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IDENTIFICATION SECTION

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The Plant Disease Reporter is issued as a service to plant pathologists throughout the United States. It contains reports, summaries, observations, and comments submitted voluntarily by qualified observers. These reports often are in the form of suggestions, queries, and opinions, frequently purely tentative, offered for consideration or discussion rather than as matters of established fact. In accepting and publishing this material the Plant Disease Epidemics and Identification Section serves merely as an informational clearing house. It does not assume responsibility for the subject matter.

THE PLANT DISEASE REPORTER

Issued by

Horticultural Crops Research Branch — Plant Industry Station, Beltsville, Maryland
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IN THIS ISSUE

The cucumber anthracnose organism can be carried by the spotted cucumber beetle and occasionally with seeds, but soil infestation apparently is not a factor in initial infection, according to Louisiana experiments reported by N. L. HORN et al., page 69.

Aerial spread by ascospores was mainly responsible for the increased prevalence of Sclerotinia wilt in bean fields in northeastern Colorado in 1956, according to DOUGLAS W. BURKE et al., page 72.

RODERICK SPRAGUE lists the fungi obtained from pear trees during studies to determine the cause of pear decline in north-central Washington, page 74.

FRAN. E. FISHER reports results of Florida tests to determine effectiveness of non-copper-containing fungicides for control of anthracnose on Rough lemon seedlings, page 77.

Virus Diseases: In comparison with common stock strawberry plants in Nova Scotia, virus-free plants gave significantly better yields, according to D. L. CRAIG, page 79. FRANK P. McWHORTER describes virus diseases of geranium in the Pacific Northwest, page 83.

Nematodes: An apparatus designed as a source of controlled vacuum for pipetting nematodes is described by HARRY W. FORD, page 89. A. MORGAN GOLDEN reports discovery of Radopholus gracilis, in California, page 91. G. MINZ reports the presence in Israel of some free-living nematodes known or suspected to be parasitic on plants, page 92.

Results of studies of resistance to the black shank fungus within the genus Nicotiana are reported by WILLIAM LAUTZ, page 95.

Antibiotics: Spraying with streptomycin sulfate or streptomycin nitrate effectively controlled wildfire in tobacco plant beds in trials reported by LUTHER SHAW et al., page 99.

Rice Disease Control: Incidence of straighthead was not affected by several different chelated compounds but a soil amendment material reduced it, in Texas tests reported by N. W. EVATT and J. G. ATKINS, page 103. Results of the uniform rice seed treatment tests in 1955-56 are analyzed by J. G. ATKINS et al., page 105.

Diseases of Cereal Crops: Leaf and culm invasion by the oat leaf blotch fungus resulted in a black-stem symptom not previously associated with the organism, according to H. H. LUKE et al., page 109. LANSING E. WILLIAMS and S. K. MENON describe their cork borer technique for inoculating corn plants with stalk-rot organisms, page 111. C. O. JOHNSTON and M. D. HUFFMAN list physiologic races of wheat leaf rust collected in the United States in 1955, page 115. R. A. CAPPELLINI and S. LUND report diseases of small grains observed in New Jersey in the 1955-56 season, page 117. Evidence reported by MICHAEL TRESHOW suggests that occurrence of terminal bleach of cereals may be associated with sudden advent of hot dry weather accompanied by high winds, page 118.

Diseases of Forage Crops: In tests with several different chemicals and various pH levels severe symptoms of chlorosis in red clover developed only when soil alkalinity was high, according to S. B. HRUSHOVETZ et al., page 120. R. A. CAPPELLINI reports forage crop diseases in New Jersey in 1956, page 123.

The estimate of losses to the cotton crop from diseases in 1956 is the fifth report by the Committee on Cotton Disease Losses, of the Cotton Disease Council, page 124.

Some Corrections, page 128.

Book Reviews, page 128: "Diseases of Field Crops", by J. G. Dickson, and "Diseases of Fruit Crops", by H. W. Anderson.

December weather, page 130.

Vol. 41, No. 2--PLANT DISEASE REPORTER--Feb. 15, 1957

SEED AND INSECT TRANSMISSION OF CUCUMBER ANTHRACNOSE

N. L. Horn, W. F. Wilson, and M. Giamalva

Abstract

Cucumber anthracnose, caused by Colletotrichum lagenarium (Pass.) Ell. & Halst. was found to be seed transmitted in 6 out of 50,000 seedlings grown from commercial seeds. The organism was transmitted by the 12-spotted cucumber beetle, Diabrotica undecimpunctata howardi Barber, in greenhouse tests. Seedlings did not become infected when grown in soil that was thoroughly infested with anthracnose 10 months previously.

INTRODUCTION

Fall-grown cucumbers have been one of the major crops in the Hammond area of Louisiana for many years. However, the acreage has decreased somewhat within the past 6 or 8 years, and losses from diseases, particularly anthracnose (Colletotrichum lagenarium (Pass.) Ell. & Halst.), have been partly responsible for the decrease. For reasons not well understood, anthracnose has become increasingly serious on cucumbers in Louisiana beginning about 1945. Certain fungicides control the disease during seasons of moderate rainfall; in excessively wet seasons, control by fungicides is inadequate. This fact, together with the expense and labor involved in applying fungicides, has discouraged some growers from raising cucumbers. The object of this investigation was to obtain information on the sources of initial infection with the idea in mind that a better understanding of the problem might lead to more effective and more economical control methods.

SEED TRANSMISSION

In order to determine whether or not the organism was carried with the seed, commercial samples, treated with Arasan by the packaging company, were planted in steamed soil in flats in the greenhouse. The seedlings that developed were allowed to grow to the 3- or 4-leaf stage at which time the plants were examined for anthracnose spots. Approximately 50,000 seedlings were observed, and 6 were found to be infected. Each infection occurred on the cotyledons. A few of the seedlings damped-off, but anthracnose was not associated with these plants. The mode of infection was not determined, however, that is, no effort was made to determine whether or not the organism was present externally or under the seed coat. These observations, in part, were noted in a previous report (3).

SOIL INFESTATION STUDIES

Although some farmers plant a spring crop of cucumbers, the fall acreage is much greater. Anthracnose has never been a problem in this area during the spring because of the hot dry weather conditions, so it seemed important to determine whether the organism might live over in the soil from fall to fall. Gardner (2) indicated that in Indiana the fungus did not persist 20 months in the soil. Under Louisiana conditions this period of survival was expected to be much shorter.

Pot Experiments: Steamed soil in 5-gallon crocks was infested thoroughly with Colletotrichum lagenarium grown on sterilized oat-grain medium. Commercial seeds were planted immediately in this soil and the subsequent seedlings became severely infected. In fact nearly all were killed before they reached the first-leaf stage. The crocks of soil were then set outside in October and buried with only the rims above ground level. Vetch was grown during the winter and soybeans during the next summer in this soil. In this way green vegetation grew in the infested soil continuously throughout the entire experiment. Ten months after the start of the test the soil was removed from the crocks, mixed thoroughly, and put in 6-inch pots in the greenhouse. Disease-free seeds were planted in this soil and the seedlings allowed to grow to the 2-leaf stage. None of the seedlings became infected with anthracnose. Disease-free seeds were planted in the same soil two more times, but none of the seedlings became infected. The entire test was repeated and similar results were obtained.

Field Tests: Field tests to determine whether or not the organism lives over from fall to fall in the soil have been tried twice in the Hammond area. Disease-free seeds were planted in soil in which severely infected plants grew the previous year and also in soil that had not been in cucumbers for at least 5 years.

The first year a limited number of disease-free seeds were available. Only eight rows 180 feet long were used. They were located next to a field planted with commercial seeds. No anthracnose occurred on the plants in these eight rows until 10 days after anthracnose had become well established in the commercial seed planting. In the second year the experiment was repeated in half-acre plots on the same farm. A smaller planting of disease-free seeds on "new" soil 50 miles away from the commercial district was also made. Anthracnose was observed at the same time in both fields at the Hammond farm. Only two infection centers were found in the planting where the disease appeared the previous year, whereas 15 infection centers were observed in the planting on "clean" soil. This suggested that the organism was not present in the soil at the time of planting, but was brought in from an outside source. No anthracnose was observed in the isolated planting even 6 weeks after it had been found at the Hammond farm.

Additional field tests with commercial seeds grown in "clean" soil and in soil on which diseased plants were growing the previous year were made over a 3-year period. Anthracnose appeared in all plantings on the same date and was equally severe. That is, in plots of approximately half an acre, there were four to six scattered initial infection centers regardless of the location of the plots. These results suggested seed transmission since the disease was observed at the same time in other commercial plantings. However, the possibility of some other external source of contamination such as insect transmission could not be eliminated.

INSECT STUDIES

The results of the field tests in which scattered initial infection centers appeared among plants grown from disease-free seed on "clean" soil could not be attributed either to soil-borne or seed-borne inoculum. They suggested some other source of inoculum. Insects were suspected.

A series of tests on insect transmission was carried out in the greenhouse. Although these tests do not definitely prove that the infested insects were the original source of infection, they do show that insects are capable of carrying the organism into a disease-free planting.

Beetles were collected in glass bottles from an area in the field where infected plants were growing. Several hours after collections were made, five of these beetles were caged on healthy plants in four pots, each pot containing ten seedlings in the second-leaf stage. The cloth coverings of the cages were kept wet for 2 days so that if spores were present the high humidity would favor germination. The plants were removed on the third day and the beetles destroyed. At the end of a week a total of 11 spots was found on the foliage of the exposed plants. Similar plants not infested with beetles were used as controls and none became infected. This experiment was repeated two more times with similar results.

In another series of tests ten beetles collected from a field where infected plants were growing were crushed in sterile water and filtered through cheesecloth. The liquid was sprayed on potted plants which were put in a moist atmosphere for 2 days. The seedlings were grown in steamed soil from disease-free seeds. Plants in 4 pots, each with 5 seedlings, respectively, were inoculated. At the end of a week 5 spots were observed. Control plants not inoculated did not become infected. Similar results were obtained in two later tests.

A third series of plants was sprayed with a water suspension obtained by rinsing ten beetles collected from infected plants. Three spots were found a week after inoculation. This experiment was also repeated two more times with similar results.

Beetles were allowed to walk for 15 minutes on an agar culture of C. lagenarium that had many conidial masses on the surface of the medium. The beetles were then caged on healthy plants kept in moist atmosphere for 2 days. At the end of a week 47 spots were counted on the test plants.

These results show that spotted cucumber beetles are possible vectors of cucumber anthracnose and that they probably play a part in dissemination. The authors did not find a report in the literature of anthracnose transmission by insects. Gardner (1) was unable to transmit the organism with beetles caged on plants. His attempts to produce the organism on agar from dilution plates of rinsed insects were negative, also.

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LOUISIANA STATE UNIVERSITY, EXPERIMENT STATION, BATON ROUGE, LOUISIANA

OBSERVATIONS ON SCLEROTINIA WILT OF BEANS IN NORTHEASTERN COLORADO

Douglas W. Burke, Janina C. Gomes, and W. G. Foeppel[1]

Sclerotinia wilt, or white mold, of beans, caused by Sclerotinia sclerotiorum (Lib.) D By., has become increasingly prevalent in the Greeley area of northeastern Colorado since it was first observed, about 15 years ago. As in other irrigated regions of the West (1, 3) this disease appears principally in heavy soils after plant foliage has shaded the soil surface enough to provide a continuously moist environment around the plant stems and after night temperatures become cool in late summer. Also, plant maturity seems to be a factor, the disease being more prevalent in plants nearing maturity regardless of the extent of foliage development. As reported from other areas (2, 3) old blossom parts are found frequently at loci of plant infections and of mycelial spread over the soil surface.

The perfect stage of the fungus, not previously reported from this area, has been considered of minor importance. However, during 1955 evidence of aerial infections by ascospores was observed in several fields. In early August 1956, after a week of cloudy, moist weather, apothecia could be found in nearly every field showing white mold[2].

As a result of the abundance of ascospore inoculum, several fields of the Tendergreen variety, grown for canning, were severely damaged and beans picked from these fields rotted in transit to the cannery. In the past beans of this upright, less viny type seldom have been affected by the disease in this locality. Many fields of the Pinto variety planted on land without a previous history of the disease also became infected.

HOSTS OTHER THAN BEAN

Among weeds growing in infested bean fields, red root, Amaranthus retroflexus L., and toothed spurge, Euphorbia dentata Michx., were found infected and bearing typical sclerotia. Also, Setaria viridis (L.) Beauv. showed watersoaked culm lesions in which characteristic sclerotia developed when the plants were stored in a refrigerator.

Other crop plants in which the disease and the perfect stage of the causal fungus were found to a slight extent were cucumber and potato. Efforts to find the disease or apothecia of the fungus in alfalfa fields in land with a history of extensive occurrence of the disease in previous bean crops were unsuccessful.

ECONOMIC IMPORTANCE

Examination of many bean fields in the heavier more productive soils during August showed few to be free from infection, and moderate to severe loss was evident in many of them.

Observations by seven bean dealers in the area cooperating in a survey indicated that 30 to 50 percent of the dry bean lots marketed at harvest time contained sclerotia in sufficient abundance to be found in tare samples. Among 40 farmers interviewed, with a total of 1108 acres of Pinto beans, the estimated losses from white mold ranged from 0 to 80 percent. The average estimated loss in yield was 9.8 bushels per acre. Also, loss in quality and value of the marketed beans was common in severely damaged fields.

White mold injury was usually greatest in fields which had borne one or more previous crops of beans since the last crop of alfalfa. On the other hand, only occasionally was a field in which alfalfa had been grown for three or more years between bean crops found with more than slight damage from the disease. Where the disease did occur in first-year bean crops, the source of inoculum was usually adjacent old bean fields or infested bean straw which had been placed on the field with manure.

The unusually extensive development of the perfect stage during the 1956 season definitely contributed to a build-up of sclerotial inoculum in many fields of the area in which the disease

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[1] Respectively, Plant Pathologists, Horticultural Crops Research Branch, Agricultural Research Service, United States Department of Agriculture, Prosser, Washington; State Department of Agriculture, Rio Grande do Sul, Brasil; and The Farr Company, Greeley, Colorado.

[2] The first observation of the apothecial stage in this area was by A. M. Hillis and F. R. Johnson of the Mathieson Chemical Company, duringthe last week of July 1956.

has not been noticed previously. It is to be expected that this will complicate the problem for coming seasons.

The importance of planting only one crop of beans in rotation with alfalfa is suggested.

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FUNGI ISOLATED FROM ROOTS AND CROWNS OF PEAR TREES[1]

Roderick Sprague[2]

A disease of pear trees in north-central Washington is widely called "pear decline". The cause is not known. Since the malady, or maladies, takes a heavy toll in the Yakima, Wenatchee and Okanogan river valleys, it has caused grave concern. The Washington State Fruit Commission and the Northwest Canners Association have contributed funds to supplement those made available by the Washington State College, United States Department of Agriculture, and Washington State Department of Agriculture. Several fulltime assistants were hired while two pathologists, two nematologists, one entomologist, four horticulturists, and one soil specialist spent part time on the project during 1956. The writer, assisted by Peggybeth Figaro and A. C. Bright, made a detailed survey of fungi associated with the crowns and roots of pear trees. Most of this work was done with trees growing in the Yakima Valley, but isolations were also made from several places in Chelan, Douglas, and Okanogan Counties, as well[3]. The writer was greatly aided in his work because he was able to make use of charted and classified pear orchards laid out by a team of workers earlier. All pear trees were classified as to vigor into five classes (Table 1) as follows: 1 - healthy; 2 - slight decline; 3 - moderate decline; 4 - severe decline; 5 - very severe decline or dying.

Isolations were made from fibrous roots, from feeder roots of various sizes up to main roots, and from crown parts. Isolations were made from all parts of these roots, sometimes from lightly scraped bark or from interior parts. All parts were washed 6 hours in tap water under a fine mist in perforated Gootch (Coors) crucibles. The parts were plated on sterile water agar and resulting colonies transferred to 2 percent potato-dextrose agar slants. All root parts were transported in the orchard soil in which they grew, in paper cartons kept on ice. Isolations were run as soon as received in Wenatchee. Many cultures were obtained from these tissues. They have been identified. The total number of isolates from each of the five classes of tree vigor is given in Table 1.

A study of Table 1 indicates that there is no correlation between the condition of the tree and the prevalence of any particular fungus or fungi. Even when broken down to number of isolates per sample, there is no evident correlation. Most of these fungi which we isolated from the underground parts are components of the rhizosphere and are not generally considered as very pathogenic. Such fungi as Alternaria spp., most of the Fusaria, such common molds as Penicillium spp., Rhizoctonia albida, Stemphylium spp. and possibly Trichoderma spp., are all very little suspect. There are some fungi of common occurrence in our isolates which need further study. These would include Cylindrocarpon radicicola, Fusarium merismoides, Mortierella sp., Pythium debaryanum, Pythium sp., Rhizoctonia solani, and Verticillium spp. Of these, Pythium debaryanum was common enough to be possibly involved in the main problem. This organism can, under moist conditions, cause necrosis of small roots. It was more common in healthy plants than in diseased, but this does not necessarily eliminate it from consideration. It is omnipresent in soils. After excision of root samples, it invades the tissues and was present in many samples, healthy and otherwise. Even in fresh samples it occurs in the outer and inner bark of necrotic trees. While we have conducted only a few pathogenicity tests, to date we have been able to induce necrosis (decline) by holding potted year-old pear trees in drowned soil for 3 days. These trees had yellowed roots full of P. debaryanum when dug up and the trees failed to rally when replanted. On the other hand, non-drowned plants continued to grow. The possibility of excess watering (a frequent condition locally) with Pythium root necrosis resulting is a point not to be overlooked in future search for the causes of pear decline.

Another local type of stunting in pears in the Wenatchee area has long been noted on nursery stock heavily infested with crown gall (Agrobacterium tumefaciens). Certain orchards show many galls on pear trees. Some Anjou trees near Malage, Washington, which we used

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[1] Washington Agricultural Experiment Stations. Project 1337.

[2] Plant Pathologist, Washington State College, Tree Fruit Experiment Station, Wenatchee, Washington.

[3] Before the start of this project similar isolation work was done in 1954 and 1955. This was reported in a paper by the writer entitled "Fungi isolated from the roots of pear trees at Wenatchee". Washington State Hort. Proc. 51: 93. 1955.

Table 1. Isolations of fungi from roots and crowns of pear trees of several vigor classes in north central Washington.

Fungus	Number of colonies isolated from pear trees of vigor classes[a] as follows:					
	1	2	3	4	5	Total
Achlya sp.			5			5
Alternaria tenuis	158	126	127	44	61	516
Alternaria sp.		4	6			10
Aspergillus sp.		3	3			6
Basidiomycetes, miscellaneous	1	1	17		4	23
Cladosporium spp.			3		1	4
Curvularia geniculata			4		1	5
Curvularia inaequalis			4			4
Cylindrocarpon radicicola	116	62	119	57	54	408
Endomyces sp.					4	4
Fusarium acuminatum	41	20	31	10	12	114
Fusarium equiseti	92	38	51	37	49	267
Fusarium merismoides	3	3	4	7	36	53
Fusarium oxysporum	112	104	132	52	44	444
Fusarium oxysporum var. redolens	21	24	16	4	9	74
Fusarium solani	44	6	6	6	16	78
Melanconium sp.		2				2
Mortierella sp.	110	97	143	49	74	473
Mucor sp.	21	8	18	11	9	67
Mycelia Sterilia	4	2	4	1	8	19
Penicillium expansum		3	4			7
Penicillium notatum	9		3	5	4	21
Penicillium sp.	11	11	7	9	5	43
Pullularia pullans	2	4				6
Pestalozzia sp.				4		4
Phoma spp.	14	7	25	8	17	71
Phytophthora spp.	1		5	4		10
Pythium debaryanum	214	85	104	91	66	560
Pythium dictyosporum	6					6
Pythium megalacanthum			2			2
Pythium pulchrum		4				4
Pythium splendens	2		4			6
Pythium ultimum		1		9		10
Pythium vexans	14		13	5		32
Pythium sp.	81	27	48	17	32	205
Polyporaceae	21	4	18		23	66
Ramularia spp.	8		14	1		23
Rhizoctonia albida	12	2	15	15	16	45
Rhizoctonia solani	34	16	51	5	20	126
Stemphylium botryosum		10	2			12
Stemphylium consortiale	62	30	38	31	30	191
Streptomyces spp.	7					7
Trichoderma köningii	28	26	80	45	10	189
Trichoderma sp.	66	5	38	31	47	187
Verticillium spp.	11	13	16	7	9	56
Miscellaneous, general	74	67	59	46	40	286
Mixed cultures	16	27	19	20	8	90
Total	1416	842	1258	632	693	4841
No. of samples	131	87	141	63	71	493
Av. Isolates per sample	10.08	9.7	8.9	10.0	9.8	9.8

[a] These vigor classes are as follows: 1 - healthy; 2 - slight decline; 3 - moderate decline; 4 - severe decline; 5 - very severe decline or dying.

in isolation work, were so infested. Of interest is the fact that replants in the same holes were badly stunted within 2 years. The roots of these replants showed numerous galls. While crown gall is not common enough to be one of the main causes of pear decline in the Yakima area, we feel that it is a factor in the decline of some of the pear orchards with crown gall history near Wenatchee.

The isolations made in 1956 were on sufficient scale to give us a comprehensive view of associated organisms. Further inoculation trials are, however, needed in the immediate future.

Acknowledgement: In addition to his associates, Bright and Figaro, the writer is indebted to all other members of the project for material assistance. He is especially grateful for the help of E. S. Degman and Lee Rosenkranz for aid in locating plots and to both the Washington State Fruit Commission and the Northwest Canners Association for funds making this study possible.

STATE COLLEGE OF WASHINGTON, TREE FRUIT EXPERIMENT STATION, WENATCHEE, WASHINGTON

CONTROL OF ANTHRACNOSE ON ROUGH LEMON SEEDLINGS[1]

Fran E. Fisher

The control of anthracnose (caused by Colletotrichum gloeosporioides Penz.) is an ever-present problem in growing rough lemon nursery stock in Florida during the spring, summer, and early fall months. With increasing acreages of groves being planted each year, the demand for rough lemon seedlings for stocks has far exceeded the supply. The desirability of rapidly growing plants to budding size has taken on increased importance. To achieve proper growth, anthracnose must be controlled, and to do this, various copper-containing fungicides have been used with satisfactory results (1). However, the use of these materials leads sooner or later to toxic accumulation of copper in the soil (2, 3). For this reason, a search has been made to find non-copper-containing substitutes for the control of anthracnose. Results of this search are being reported here.

On the basis of preliminary laboratory tests, ferbam and captan were compared with copper in field tests during 1953. Twelve plots of 5-month-old rough lemon seedlings, each with 5 rows 3 feet long, were used. Randomized treatments were begun on September 23, 1953, and were applied at intervals of 7 to 10 days until December 2, at which time dry, cool weather lowered the incidence of anthracnose infection. Rates of application were: ferbam 2 1/2 pounds, captan 2 1/2 pounds, and tribasic copper 1 pound to 100 gallons.

Inspection of foliage and growth of treated plants on January 18, 1954 indicated that ferbam gave more control and resulted in larger plants than either captan or copper (Table 1).

Table 1. Height of rough lemon seedlings, number of healthy leaves, and total number of leaves following fungicide trials for control of anthracnose, 1953-54*.

Treatment	lbs./100 gals. water	Mean inches height	Mean no. healthy leaves	Mean no. total leaves
Ferbam	2 1/2	8.93	7.11	16.34
Captan	2 1/2	6.40	4.88	12.20
Tribasic copper	1 lb. (50%)	5.94	5.76	13.13
Non-sprayed control	---	4.79	2.71	9.19
L.S.D.	(19:1)	2.13	1.67	2.90
	(99:1)	---	2.53	3.21

* Figures represent the means of measurements on 99 plants.

In 1956, spraying tests were again carried out, this time with the following materials: ferbam 1 1/2 pounds, ferbam 2 pounds, captan 2 pounds, zineb 1 1/2 pounds, and copper sulfate 2 pounds to 100 gallons. The first spray was applied on July 31 and subsequent sprays were applied on August 7, August 16, August 25, and September 4. Three rows of 1-year-old seedlings, each row being 60 feet long, were used. Each row, separated by an untreated row, was divided into six plots. Treatments were replicated three times and randomized both as to rows and position in the rows.

Six weeks after the initial application, plants which had been sprayed with ferbam or zineb had more healthy leaves (Table 2) than those sprayed with captan or copper. There were fewer plants with dead terminals in ferbam-treated plots than in all others, although all fungicides were significantly effective when compared with untreated controls.

During the 1956 test, a period occurred during which infection took place by the scab-producing organism, Elsinoë fawcetti Bitancourt & Jenkins. An opportunity was afforded, therefore, to assess the capacity of these fungicides for controlling scab also. Of the plants sprayed with ferbam and zineb, fewer were infected with scab than of those sprayed with other materials, despite the fact that all treatments gave significant control over untreated checks.

[1] Florida Agricultural Experiment Station Journal Series No. 582.

Table 2. Number of rough lemon seedlings with dead terminals, number of healthy leaves per plant, and number of plants infected with scab, in treated as compared with untreated plants, 1956*.

Treatment	lbs./100 gals. water	Mean no. of plants with dead terminals	Mean no. of healthy leaves	Mean no. plants infected with scab
Ferbam	1 1/2	0	5.96	.01
Ferbam	2	0	6.75	.02
Zineb	1 1/2	.07	5.23	.09
Captan	2	.04	3.17	.16
Copper sulfate	2 lb. (55%)	.07	4.17	.15
Non-sprayed control	---	1.18	2.64	.68
L.S.D.	(19:1)	.11	1.70	.06
	(99:1)	.16	---	.09

* Figures represent the means of measurements on 99 plants.

In tests conducted in 1953-54 and 1956, ferbam provided more protection from anthracnose than any other material tested. In 1956, ferbam also gave the best control of scab. In 1956, ferbam and zineb gave better control of anthracnose than captan or copper. From the standpoint of avoiding copper toxicity, the use of either ferbam, zineb, or captan is preferable to the copper-containing fungicides now generally in use.

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A TWO-YEAR COMPARISON OF VIRUS-FREE AND COMMON STOCK STRAWBERRY PLANTS[1]

D. L. Craig

Abstract

The yield data from a two-year trial of virus-free and common stock strawberry plants indicates that virus-free plants give a significant yield increase over common stock.

The necessity of isolating virus-free stock from common stock to prevent virus infection, even though an insect control program is used, is indicated by the data.

INTRODUCTION

The per acre commercial yield of strawberries in Nova Scotia is extremely low. A survey by Retson and Heighton (14) based on data collected from 56 strawberry growers stated that their average yield in 1951 was 2239 quarts per acre. Runner-grafting tests using the technique described by Harris and King (8) and carried out in the greenhouse at this Farm have revealed that the stock commonly planted by local growers is infected with virus disease. Furthermore, observations made on varieties which show foliar symptoms of virus also substantiate the conclusion that virus infection of the strawberry stock is general. That this condition is not confined to Nova Scotia is indicated by Demaree and Marcus (6) who reported in 1951 that nearly all plants of eastern United States were virus infected.

The introduction in 1953 of virus-free strawberry plants by the U. S. Department of Agriculture (12) afforded an opportunity to test virus-free plants against the type of stock utilized by Nova Scotia strawberry growers.

Preliminary tests have already been made by a number of workers in the United States. Darrow (4) reported that J. S. Bailey in Eastern Massachusetts recorded an average yield of 10130 quarts per acre for virus-free Catskill, Howard 17 (Premier), Robinson and Sparkle, and 7803 quarts per acre for ordinary stock of the same varieties. He also reported that in a similar comparison A. P. French at Amherst, Massachusetts, recorded an average yield per acre of 10600 quarts for virus-free stock and 7808 quarts per acre for ordinary stock. Hill and Gould (9) reported an average yield of 6926 quarts per acre for virus-free Catskill, Sparkle and Howard 17 (Premier) and 4123 quarts per acre for ordinary stock.

Becker and Rich (1) reported that the average number of runners per mother plant for 10 individual clones of virus-free Catskill, Premier and Sparkle were 89, 160 and 95 respectively, compared to 39, 93 and 81 for local plants of the same varieties. The average yields per clone of the virus-free Catskill, Premier and Sparkle were 10.6, 13.5, and 10.9 quarts respectively, compared to 3.9, 8.0 and 7.2 quarts, for the local plants.

In 1955 G. C. Warren (15) had an average yield increase of 5001 quarts per acre in favor of the virus-free varieties Catskill, Sparkle and Howard 17 (Premier) when compared with regular stock.

Though all these tests were based on limited data, the results support the observation that virus-free plants are superior in their growth and yield to common stock, even though the latter may show no visible evidence of virus infection.

In contrast, Brown (2) has reported that test plantings of virus-free Premier plants were not superior to the Ontario Premier common stock which are known to be infected with a mild strain of virus (7). Hunter (11) supported this opinion and stated that Ontario growers were satisfied with the yields received from their regular stock.

Observations made at Kentville on the fruit and foliar characteristics of virus-free and common stock varieties Catskill, Premier, Senator Dunlap and Sparkle, indicated a distinct difference between the two Premier stocks. Though the general fruit form and size were the same, the exterior and interior fruit color of the virus-free Premier was lighter and they were considerably more acid in flavor than common stock Premiers. The foliage of the virus-free plants was also lighter in color, and they fruited a day or two later than the common stock.

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[1] Contribution No. 892 of the Horticulture Division, Experimental Farms Service, Canada Department of Agriculture.

Table 1. Yield data in pounds per acre from the 1954-55 and 1955-56 virus-free and common stock strawberry test.

Source of material	1955 mean lbs.	1956 mean lbs.
Catskill (Exp. Farm)	5837	14201
Catskill (virus-free)	17424	15246
Sparkle (Exp. Farm)	6912	8567
Sparkle (virus-free)	21461	20038
Premier (Exp. Farm)	3630	8944
Premier (virus-free)	15856	13533
Senator Dunlap (Exp. Farm)	4675	7231
Senator Dunlap (Woodworth)	6824	8189
Senator Dunlap (virus-free)	13126	10745
Mean (Exp. Farm)	5263	9735
Mean (virus-free)	16966	14891

1955 L.S.D. P.01 = 4153; P.05 = 3078

1956 L.S.D. P.01 = 4153; P.05 = 3078

It seems unlikely that this distinct difference is entirely due to virus infection and suggests that the two stocks may be of two distinct genetic strains of the same variety.

The present paper is a report based on two years' results comparing the yield of virus-free stock with common stock grown at the Experimental Farm, Kentville, Nova Scotia.

MATERIALS AND METHODS

The virus-free stock used in this experiment was imported from a nursery in the United States which had propagated indexed stock released from the U. S. Department of Agriculture Station at Beltsville, Maryland (12). The common stock in the test came from the Experimental Farm propagation beds. This latter stock had been maintained on the Experimental Farm for a number of years and was fully exposed to many possible sources of virus infection. One outside source of Senator Dunlap stock was obtained from a local grower who consistently has produced crops far above the average yield indicated for Nova Scotia by Retson and Heighton (14). This stock, however, has been found by Hunter (10) to be uniformly infected with a virus.

The 1954 and 1955 plot arrangements were identical. Four replications were used, containing nine randomized plots. Each plot contained a single row of 20 plants spaced 1.5 feet apart. The rows were 5 feet apart, and the plants were allowed to runner freely to form a matted row.

The virus-free stock used in 1954 was planted directly to the field shortly after it was

received. Both virus-free stock and common stock for the 1955 planting were obtained by taking equal numbers of plants from each of the 1954 plots and setting them in corresponding plots in the 1955 test.

The plot areas used for the two tests had not been previously planted to strawberries.

During the entire growing season of both 1954 and 1955 all plots included in the test were dusted at 10-day intervals with a 4% malathion dust.

RESULTS

The yield records have been summarized in Table 1 for each of the two years. The 1955 data show that there was a significant difference at the 1% level of probability between the yields of the common stock and virus-free stock for each variety. In 1956 there was a significant difference at the 5% level of probability for the three varieties Premier, Senator Dunlap and Sparkle, but the two stocks of Catskill showed no significant difference.

DISCUSSION

This test conducted for a period of two years indicates clearly the value of virus-free strawberry stock. The yields from the virus-free plants in 1955 were higher than in 1956, which is what one would expect in view of the degree of exposure of the virus-free stock to possible reinfection.

The virus-free varieties showed a significant second year yield decrease, suggesting that some virus reinfection may have occurred. Posnette and Bovey (13) have reported that even following a routine spray schedule for insect control reinfection occurred at the rate of 10 percent the first year, 50 percent the second and 100 percent the third year. Darrow (3) also reported that even with careful dusting with an insecticide to control the aphids which transmit the virus, some infection of the stock used in the second year planting could be expected to occur if common stock was adjacent to the virus-free stock. The 1956 yield data suggest that this probably occurred, causing a reduction in yields.

In contrast to this change it will be noted (Table 1) that the 1956 yield of common stock was considerably higher than that in 1955. One possible explanation for this increase lies in the method used to secure the planting stock for the two years. In 1954 the common stock was taken without selection from a large number of average quality plants dug from a single propagation row. In order to retain the same type of plant material, the plants in 1955 were taken from the 1954 plots by digging equal numbers of plants from the sides and from the ends of each plot. In doing this, the larger and more vigorous ones were selected, and the weak portions of the row bypassed. The common stock rows lacked the uniformity of the virus-free rows both in vigor and in runner production, and were quite irregular due to the low vigor of certain mother plants. The protection afforded by the insect control program would have reduced further virus infection to a minimum, and any relatively healthier stock in the common stock row would have had a tendency to remain that way. It was these thriftier plants that were utilized for the 1955 plots.

Darrow, Goheen, and Miller (5) pointed out that there are wide varietal differences in plant tolerance to infection by a particular virus.

The variety Catskill is known to be sensitive to virus and following infection quickly degenerates. In the case of the common stock Catskills it would seem quite probable that plant improvement could have occurred through selection of the more vigorous plants, and may account for their marked increase in production in 1956.

In Ontario where Premier is the predominant variety it may not be so important to grow only virus-free plants as it would be in areas where several varieties varying in tolerance are planted in the same field. This danger was illustrated by Harris and Hildebrand (7), who found that a rapid degeneration occurred in Ontario Premiers following the introduction of a second virus into the Premier plant.

Most of the common stock varieties grown in Nova Scotia have been planted in mixed varietal fields both in the nurseries and commercially. This could account in large measure for their poor performance, and indicates the potential commercial value of using virus-free stock.

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CANADA DEPARTMENT OF AGRICULTURE, KENTVILLE, NOVA SCOTIA

VIRUS DISEASES OF GERANIUM IN THE PACIFIC NORTHWEST

Frank P. McWhorter[1]

This report is based on 1) surveys of greenhouses in the Pacific Northwest for virus diseases of geranium, Pelargonium spp., 2) collections of plants to illustrate the various symptoms, 3) a study of the comparable growth of selected plants, and 4) preliminary analyses of the diseases by attempting to isolate the viruses.

The florist-to-home grower trade in potted geraniums was about one million plants in Oregon and Washington during 1956. This large production of geraniums by florists was accompanied by large losses from virus diseases. Comparatively few florists in this area now propagate from cuttings taken from their own stock-plants. Most of the plants are grown from cuttings shipped in from California during the early fall. The virus diseases become noticeable in the small plants during January and February. The principal diseases, crinkle and the disease here called leaf breaking disease, continue to increase in severity until around March 1; then recovery may start but the plants are still unsightly at the peak of the sales during April and May. Some of the other diseases here discussed continue throughout the summer and the plants may be dead or dying by fall.

The seasonal habits of virus diseases of geranium make them difficult to investigate because of the uncertainty of geraniums chosen as test-plants for inoculation purposes. Two years are required to grow seedlings suitable for inoculation. We have found also, that one of the diseases, leaf breaking, is occasionally seed-borne and that some seedlings have to be discarded. The problem is further complicated by the fact that when a plant severely diseased with crinkle is cloned, many of the descendants may not show evidence of the disease for an entire season while some of its sister-plants growing under the same conditions may show symptoms prominently. At least 3 years are required to complete a reliable inoculation program on the principal virus diseases of geranium.

SYNOPSIS OF VIRUS AND VIRUS-LIKE DISEASES OF GERANIUMS OBSERVED IN THE PACIFIC NORTHWEST

A. Affected leaves crinkled or roughened.

1. Young spots hyaline; older spots more opaque, yellowish, often marked with tiny necrotic areas — CRINKLE

B. Affected leaves not crinkled or roughened.

a. Affected leaves of normal shape, not deformed.

2. Conspicuous yellow or white spots on occasional leaves only. Form of spots variable, often ring- or arc-shaped — SPOTTED WILT (?)

3. Leaves bright colored, coarsely spotted with reds or yellows especially on edges of leaves. Symptoms strongest on older leaves. Not virus. — DEFICIENCY DISEASES

b. Leaves shaped like the leaves of a ginkgo tree during severe stages of the disease.

4. No spots or lesions on affected leaves. Purplish areas of varieties having zonate foliage are confined to veins or wanting. Obscure mottle may be present. Leaf blades appear shorter than normal. Symptoms strongest on young leaves. LEAF BREAKING

c. Leaves strongly cupped.

5. Indumenta smooth, shiny — LEAF CUPPING

[1] Plant Pathologist, Oregon Agricultural Experiment Station, Agent, Ornamental Plant Section, Agricultural Research Service, United States Department of Agriculture.

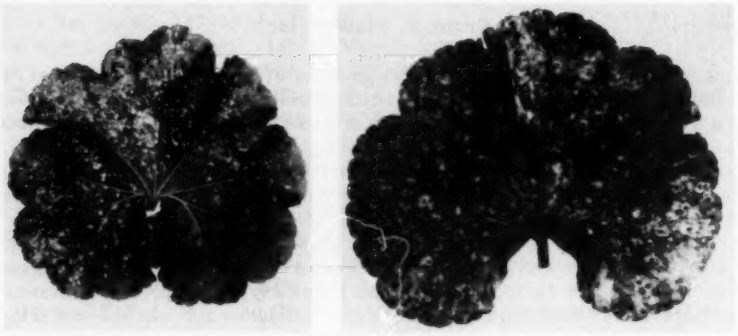

FIGURE 1. - SPOTTED WILT - ? White, yellow, and sometimes red markings considered to be symptoms resulting from the presence of spotted wilt virus. This disease has been confused with crinkle. These leaves from geranium varieties Gregson White (left) and Mrs. Lawrence (right). Photographs by H. H. Millsap.

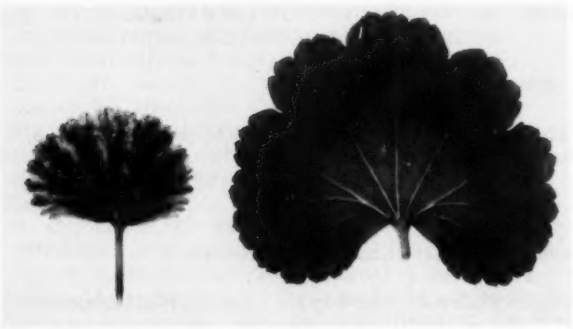

FIGURE 2. - LEAF BREAKING. Normal and broken leaf on the variety Pink Supreme. The leaf on the right, with purple horseshoe pattern, is a normal leaf formed during the summer. The leaf on the left, formed during November, shows strong leaf breaking symptoms; the horseshoe pattern has disappeared. Photograph by H. H. Millsap.

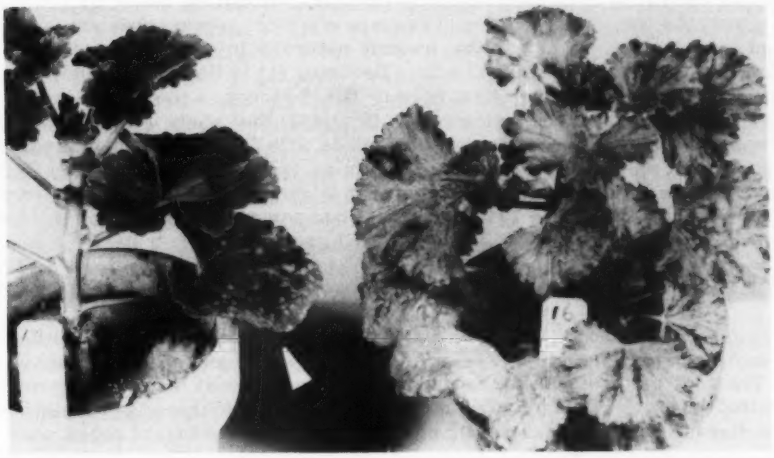

FIGURE 3. - LEAF BREAKING AND SPOTTED WILT. This photograph shows two Pink Supreme plants developing symptoms during April 1956. The plant on the left is normal except for one lower leaf that developed symptoms indicative of spotted wilt. The leaves of the plant on the right are in the leaf breaking stage. Note that all traces of the purplish horseshoe pattern have disappeared. This plant recovered during June and July and later formed the foliage shown in Fig. 2 that represents leaves from this same plant. Photograph by H. H. Millsap.

DISCUSSION OF THE VIRUS DISEASES

CRINKLE:- Synonyms: Kräuselkrankheit; Gelbfleckenkrankheit; Geranium Leaf Curl.

Crinkle, first described as "dropsical" by Halstead (3) in 1893, and attributed to an imbalance of water, was recognized as a virus disease in 1932 independently by Pethybridge and Smith (10) in England and by Verplancke (14) in Belgium. That the disease is graft-transmissible was shown by several European workers and later investigated in detail by Berkeley (1) in Canada and by Jones (5) in Washington State. All previous investigators, with the possible exception of Verplancke[2], reported the disease as due to a virus that is not sap-transmissible.

When typically developed, crinkle is unmistakable. The young leaves are wrinkled and deformed with hyaline spots that are slightly thickened. These spots, as first pointed out by Verplancke (14), are composed of white hypertrophic cells. With age, the spots may yellow and develop small necrotic areas. This disease has been well illustrated frequently in technical (5, 6) and popular articles and in books on ornamentals. Crinkle is not similar to leaf breaking (mosaic). It is questionable whether the causal virus should have been placed in Holmes' genus Marmor (4). It is not a mosaic-like disease. On the contrary it is distinguished by characteristic crinkling of leaves and specific cell growth that forms the hyaline spots in leaves. The disease can be confused with spotted wilt (11) unless the suspected plants are examined from below. The hyaline spots of true crinkle transmit light like tiny windows.

We have developed a specific test for this crinkle disease. A virus has been isolated from typically diseased geraniums to snapdragon and other test-plants more than 100 times. The test for this virus, and its placement with respect to the viruses of the leaf curl disease

[2] His reported transfer of a virus from geranium to tobacco has not been confirmed by other investigators and the virus we consider responsible for crinkle will not transfer to tobacco.

of cotton and the infectious chloroses of the Malvaceae, will be discussed in a separate paper.

Based on surveys and conferences with florists who have grown geraniums from seed, and increased them into named clones that became naturally infected with crinkle, it is suspected that the likely vector is a white fly. Berkeley (1) in Canada concluded likewise from his general observations. One trial here by Dr. Swenson, using Bemisia sp. as a vector, produced extremely severe symptoms in 1/10 plants; that study is still in progress.

In a survey of geraniums in the Seattle area made with Charles F. Doucette[3] during April 1956 it was found that the number of diseased plants varied with the variety and the California source. Counts made on 17 varieties indicated that there was less crinkle noticeable than when Jones (5) made his studies in 1940. A direct comparison, however, cannot be made because only a few varieties listed by Jones are still grown.

SPOTTED WILT?:-

A disease that forms bright yellow or white spots, often arc- or ring-shaped, was observed on many plants and varieties (Fig. 1, 3). Usually only an occasional leaf shows the symptoms. The spot-patterns and the fact that only an occasional leaf shows symptoms are typical of spotted wilt virus living over in a comparatively thick-leaved perennial. Some stages of this disease can be confused with crinkle because of the bright appearance of the chloroses; also both viruses are often present on the same plant. Thus the photograph of crinkle used on page 736 by Post (11) in his text book for florists, may be a picture of a double infection, the lower leaf showing spotted wilt symptoms.

Spotted wilt has likely been generally mistaken for crinkle and thus its presence has not been recognized by American florists. Our test for crinkle virus has proved negative on plants that show only suspected spotted wilt symptoms. Surveys indicate this disease is present in a large percentage of the plants grown from cuttings shipped from California.

That these bright-colored patterns on geranium leaves are truly due to spotted wilt virus has not been proved. Mechanical techniques have failed to transmit the virus to solanaceous test-plants; transfer by thrips has not yet been attempted. Geraniums are injured only slightly by the disease, but if the virus is spotted wilt, infected plants could be dangerous neighbors to susceptible annuals.

LEAF BREAKING:- Synonym: Mosaic.

The name "leaf breaking" is suggested for this disease because it does not produce a true mottle but does completely rearrange and/or reduce the anthocyanin pigments in the leaves. The purplish zones or horseshoe patterns that make the foliage of many varieties attractive are formed by pink pigments in epidermal cells, especially those grouped around trichomes. When this disease is present, the horseshoe pattern disappears and is replaced by purple spotting along the veins; in some cases formation of anthocyanin pigments is completely suppressed. Thus the distinctive symptom of the disease is comparable to flower breaking. The foliage of a zonate variety is so changed during part of the season that the plants appear to belong to a different variety! (Fig. 3).

The leaves are reduced in size during severe stages of the disease and then have the appearance of a ginkgo leaf (Fig. 2). This circumstance is useful for diagnosing the disease in varieties that do not have purpling on the leaves. There is also a slight reduction in chlorophyll-green coloration but we have not seen a distinct chlorophyll-mottle among several thousand specimens examined. Like crinkle, the disease is seasonal, severe symptoms being apparent in the short-day months followed by nearly complete recovery during the long-day months. Usually the new foliage is symptomless when the plants bloom, indicating a low concentration of the virus; that may explain why the flowers show no discolorations. A study of specimen plants indicates a slight reduction in growth even when the plants are forming normal leaves.

The cause of this disease is unknown as the etiology has not been demonstrated, although

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[3] Entomologist, Entomology Research Branch, Agricultural Research Service, United States Department of Agriculture, Sumner, Washington.

[4] We are unable to make specific references to the occurrence of spotted wilt in geranium. The virus has been listed on geranium by various investigators but no proof of the occurrence seems to have been made by anyone and we find no record of an investigation of the disease.

it is very probably due to strains of cucumber mosaic virus. Wellman (15) in 1935, infected geraniums with his celery strain of CMV but did not describe the symptoms. Smith (13) infected geraniums with his "Cucumis Virus 1" by mechanical inoculation but was unable to recover the virus except with Aphis gossypii Glover. Jones (5) described this disease and concluded it was only graft-transmissible. Likewise we have been unable by mechanical techniques to transfer a virus from typically infected leaves to tobacco, cucumber, or Croft lily. It is suggested that this is another case where strains of CMV become fixed in a perennial host and difficult to isolate. The anthocyanin rearrangement is compatible with CMV-etiology and in one instance a seedling developed the disease shortly after emergence. A study of the etiology by vector techniques is being made.

Our surveys show that the amount of this disease has increased enormously since Jones made his surveys in 1939. He records for different greenhouses 0 to 6 percent for most varieties and 1 to 40 percent for one variety. In our survey we noted large blocks of Better Times and Olympic Red that had 100 percent of the plants infected; the disease was present in many other varieties. The growers are becoming very conscious of this disease that changes the zonate leaf form to the plain leaf habit.

LEAF CUPPING:- Synonym: Curly Top?

Leaf cupping, the most distinctive and destructive virus disease we have observed affecting geranium, is apparently rare in commercial stocks. Only six affected plants were observed by us during the 1956 surveys.

The disease changes the form of the plant to a shape that no longer has the appearance of a geranium. For example, all the leaves of an affected E. J. Hill geranium were changed from the normal flat pubescent form to incurved glabrous cups.

Leaf cupping was described by Severin and Freitag (12) in 1934 from naturally infected plants collected in the San Joaquin Valley of California. Curly top virus was recovered from these plants by using the beet leaf-hopper, Eutettix (=Circulifer) tenellus Baker, as a vector. Later, they reproduced the disease by introducing the virus into geranium seedlings by means of infected hoppers. The infected seedling geraniums developed leaf cupping symptoms similar to those we have observed in local greenhouses. Their illustration, plate 3, is of special interest to this discussion because they seem to have confused other diseases, Fig. E, with acceptable curly top symptoms shown in Figs. A, B, C, and D. The protuberances such as they describe and illustrate were shown by Garman (2) to result directly from injury by insects during feeding, and the rearrangements of pigments indicated in the lower photograph of Fig. E may be truly the first record of the leaf breaking disease of geranium. Their paper, however, clearly establishes curly top virus as a cause of a leaf cupping disease of Pelargonium.

THE CONTROL PROBLEM

Control for the florists concerned must be effected by obtaining virus-free cuttings. Since at least 99 percent of these virus-diseased plants are introduced into the Pacific Northwest as infected cuttings, some florists are considering again growing their own stock plants and making their own cuttings.

Since the common viruses produce severe symptoms only in small plants it is probable that these viruses have progressively lower concentrations in the upper foliage as the plants reach maturity. That such is actually true in crinkle-infected plants during regression of symptoms is indicated by attempts to isolate the virus from recovered plants. The virus is easily isolated from older affected leaves by the spatula technique (7) but has not been isolated from the symptomless upper leaves of recovered plants. Such observations indicate that tissue-cultures from the meristematic areas of the tips of selected apparently healthy plants would be a usable approach to growing virus-free plants from some of the established commercial varieties. Thus the situation does not seem as hopeless for current varieties of geranium as is indicated by Munnecke (8). Papers such as that of Munnecke and Chandler (9) on how to grow disease-free geranium stock should alert wholesale growers of geranium cuttings. Also, our surveys do indicate that some sources of cuttings are already comparatively free from viruses.

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A SOURCE OF CONTROLLED VACUUM FOR PIPETTING NEMATODES[1]

Harry W. Ford

The use of a micro-pipette for routine selection of desired nematodes from a dish of mixed specimens has been limited by the requirements of the low vacuum applied to the pipette. Most aspirator sources cannot be critically controlled. The use of a rubber bulb or applying mouth suction requires considerable sensitivity by the operator.

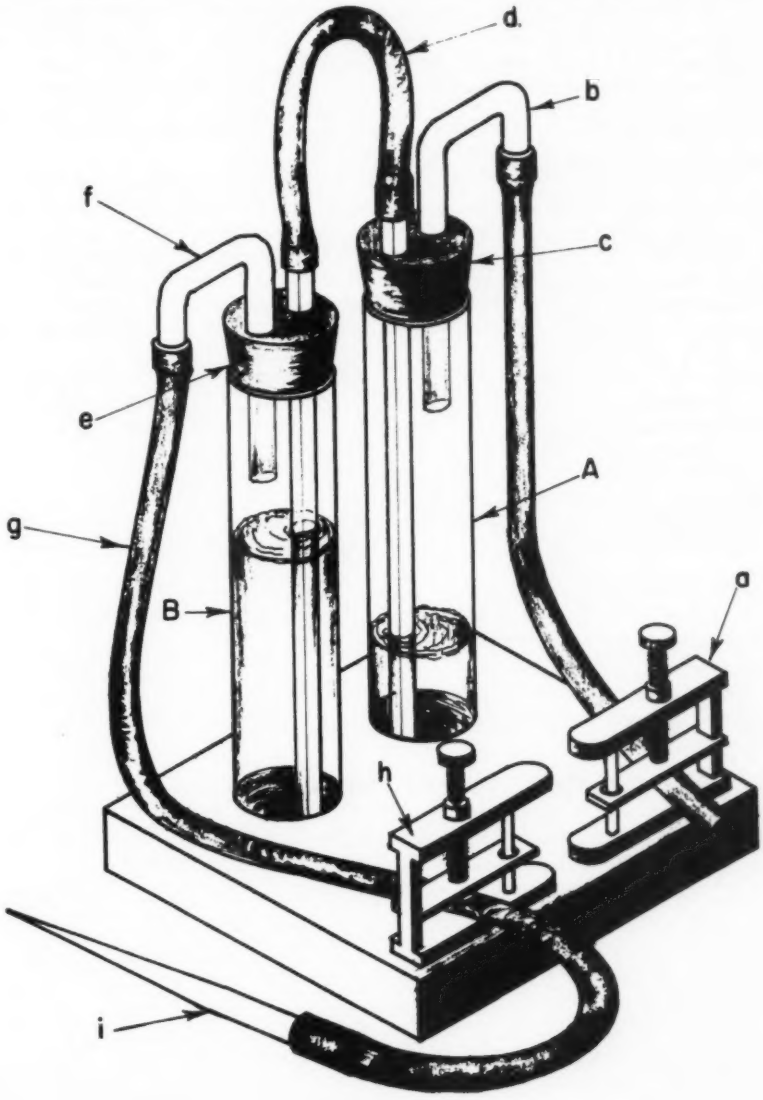

FIGURE 1. Controlled vacuum apparatus.

[1] Florida Agricultural Experiment Station Journal Series, No. 584.

The apparatus described applies a constant controllable suction while the tip of the pipette is under water. The source of suction consists of two 25 x 200 mm test tubes (Fig. 1). The tubes A and B are connected by a siphon (d) made of capillary glass tubing and 1/8 inch diameter rubber tubing. The capillary tubing, although not absolutely essential, prevents rapid changes in water level when clamps are open. All other glass parts including the pipette are made from 1/8 inch I. D. tubing. The exhaust line (b) is equipped with a screw compressor clamp (a) mounted on the base plate. The intake (f) is connected to the pipette (i) by any desired length of 1/8 inch diameter gum rubber tubing (g). A screw compressor clamp (h) mounted securely to the base plate is used to control the rate of suction. The unit described is compact, portable, and cheap to construct. Modifications in construction, based on the concept of a closed siphon system, can be made to suit individual preferences. For example, larger containers for A and B can be used if desired.

Before attaching the pipette, suction is applied to the rubber tubing (g) until the water level in B is 4 inches higher than A. Close clamp (h). Wait a few seconds for tension to develop in tube B, then close clamp (a). The system should be made airtight. Use a seal around the rubber stoppers (c) and (e) if necessary.

The pipette, made from glass tubing drawn to a fine point, must be primed by blowing through it and placing the tip immediately in water for a few seconds to wet the capillary portion of the tip. The pipette will not function unless water, free of air bubbles, is in the tip. The pipette is attached to the rubber tubing and the tip held close to a nematode. The compressor clamp (h) is opened slowly until the desired suction is obtained. Pipetting action will stop automatically when the tip is lifted above the surface of the water because surface tension at the tip is greater than the vacuum applied to the pipette. Thus, air cannot enter the pipette while it is being used.

Exhaust clamp (a) should remain closed until the vacuum has decreased considerably. Opening clamp (a) for a few seconds will restore vacuum, providing condensed water droplets or dirt have not clogged the tubing at clamp (h). If this should occur, open both clamps (a) and (h) for a few seconds. The vacuum will usually function for 10 minutes before it is necessary to open clamp (a). The use of clamp (a) in the apparatus is necessary to prevent a gradual increase in vacuum and for critical control at clamp (h).

When pipetting nematodes, the pipette should be held at an acute angle. The pipette will cease to function when the height of the meniscus above the tip equals the hydrostatic head in the test tubes.

The pipette will not leak when disconnected from rubber tubing (g) so that it is necessary to blow the suspension of nematodes from the pipette. The pipette should be rinsed to insure that all nematodes have been displaced.

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OCCURRENCE OF RADOPHOLUS GRACILIS (NEMATODA: TYLENCHIDAE) IN THE UNITED STATES

A. Morgan Golden[1]

The plant nematode, Radopholus gracilis (de Man, 1880) Hirschmann, 1955, has so far been reported only from Russia and certain European countries where it was found by different workers in soil and in association with various kinds of plants. In giving its habitat and distribution in 1955, Hirschmann[2] noted that this organism had been reported as follows: by Micoletzky in boggy soil in Rumania, on the leaves of Potamogeton from the Volga river in Russia, and on mossy stones of a lake bank and from a meadow adjacent to a lake in Denmark; by de Man in moist woodland and pasture soils in Holland; by Rahm on Polytrichum in Germany; by Franz in marshy land and from a moist grass hollow at an altitude of 6885 feet in Austria; by Franz and Beier in marshy ground with Carex and Primula farinosa in Austria; by Andrassy between the roots of a water lily growing in a pool containing sodium salts in Hungary; by Hirschmann in the mud around the roots of Caltha palustris from a brook and from lake banks in Germany; and by Meyl between the roots of Phragmites communis in a drainage ditch with .004% salt content in Germany. Apparently there are no reports of the finding of this nematode within the roots of plants, or other evidence of its parasitism.

Recently R. gracilis was found in soil and certain root samples from monocotyledonous plants growing in moist soil along the edge of the Pajaro River near Watsonville, California. Soil from around the roots of Greene's bur-reed (Sparganium greenei Morong) had a light population of this nematode together with various other forms. Examination of soil samples taken later from other plants in the same general area revealed its presence in small numbers in association with bull tule (Scirpus paludosus A. Nels.) and threesquare (S. americanus Pers.). No nematodes were observed within the roots of the latter two plants. In the case of the Greene's bur-reed, however, some specimens of R. gracilis were obtained when the washed roots were either placed for about 24 hours in Petri dishes containing a small amount of water or were processed by the Waring Blendor method of Taylor and Loegering[3]. Further, after some of the roots of Greene's bur-reed were stained in lactophenol with acid fuchsin, a few mature specimens of the nematode could be seen lying in the parenchymatous tissue just beneath the epidermis. Some immature specimens and an occasional egg were also observed. The presence of specimens within the roots, even though in small numbers, indicates that R. gracilis is an endoparasite as are two other Radopholus species (R. similis and R. oryzae), both of which are recognized as serious plant parasites. There seemed to be no specific root symptoms associated with the presence of the nematodes. This might have been due at least in part to the small number of specimens present, the type of plant and the poor condition of the roots when examined. Potted plants, including sugar beets, have been inoculated in an attempt to establish the organism in culture for possible further investigations.

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FREE-LIVING PLANT-PARASITIC AND POSSIBLE PLANT-PARASITIC NEMATODES IN ISRAEL[1]

G. Minz[2]

This is the first record of free living plant-parasitic and possible plant-parasitic nematodes in Israel, collected from August 1955 to June 1956. The nematodes were recovered from diseased material (mainly roots) and from soil surrounding roots of declining plants. Where living roots were available, nematodes were additionally removed by the method described by Young (2).

This paper covers 22 genera of nematodes derived from 44 plant species and surrounding soil, obtained from localities scattered throughout the country. Some of the plant species were examined once, but others, e.g. avocado, banana, citrus, fig, mango, strawberry, Kikuyu and St. Augustine grasses, were sampled many times, either from the same or from various localities, throughout the season.

In addition, a number of non-parasitic nematodes are also listed at the end of the paper.

1. Aphelenchoides spp. was found in soil samples surrounding apples, banana, barley, peach, strawberries, wheat, Kikuyu grass, St. Augustine grass and Bromus sp.

2. Aphelenchus spp. was found on 28 plant species, including alfalfa, avocado, banana, citrus, eggplant, oats, peanut, pepper, potato, wheat.

3. Criconemoides sp., on avocado, Kikuyu grass, and Ficus nitida Thunb.

4. Discolaimus sp., on pepper, plum, St. Augustine grass, Cereus sp., Mammilaria spp., and Urtica sp.

5. Ditylenchus dipsaci (Kuehn 1857) Filipjev, 1936 was found in an experimental plot, causing dwarfing of oats and swelling of the base of plants.

5a. Ditylenchus spp. caused decline in strawberries, and probably participated in the decline of Kikuyu grass and St. Augustine grass. It was found also in soil from apple stocks, avocado, citrus, fig, and wheat.

6. Dorylaimus spp. was found in soil with most of the plants examined, including cereals, grasses, legumes, vegetables, fruit trees, industrial plants, and ornamentals.

7. Helicotylenchus sp. On anona, avocado, banana, mango, and St. Augustine grass this nematode was found to cause substantial damage. It was found also with soil from other plants: apple, papaya, peanut, plum, quince, wheat, Kikuyu grass, Urtica sp.

8. Hemicycliophora (? typica), on Kikuyu grass.

9. Hoplolaimus sp. was found associated with other nematodes, probably participating in decline of banana and fig. Found also with plum and Cereus sp.

10. Paratylenchus sp., found with a dying apple tree.

11. Paurodontus sp., was found in soil with banana, bitter almond, carrot, peanut, pepper, strawberry, tomato, wheat, and Kikuyu grass.

12. Pratylenchus brachyurus (Godfrey 1929) Sher & Allen 1953 was found associated with other nematodes in soil from Cavendish banana.

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[1] Agricultural Research Station, Rehovot, Israel. 1956 Series, No. 168-E.

[2] Plant Pathologist and Nematologist, Agricultural Research Station, Rehovot, Israel. Many of the identifications were made by Mr. A. L. Taylor, Mr. Gerald Thorne, and Dr. M. W. Allen.

12a. Pratylenchus minyus Sher & Allen 1953, with roots of fig tree.

12b. Pratylenchus penetrans (Cobb 1917) Sher & Allen 1953, in soil from banana.

12c. Pratylenchus scribneri Steiner 1943, in soil from banana, fig, plum, and quince.

12d. Pratylenchus spp. In many instances the nematodes were recovered from roots (2), but in general, from soil under apple, eggplant, Yunnan peach, pepper, potato, strawberry, tomato, wheat, Kikuyu and St. Augustine grasses.

13. Psilenchus sp. abundant about roots of vulgare wheat

14. Radopholus sp., in soil around roots of apple stock Hashabi, banana, bitter almond, Shalil peach, plum stock Marianna, and St. Augustine grass.

15. Rotylenchulus sp., non-mature females found in soil around bananas in one grove. No damage signs.

16. Rotylenchus spp., including a short form resembling R. robustus (de Man 1880) Filipjev 1934 on banana. This and other species cause decline (similar to that mentioned under Helicotylenchus sp. in other localities) in avocado, banana, Kikuyu and St. Augustine grasses. Found also in soil from alfalfa, apple, barley, fig, peanut, strawberry, tomato, wheat, Cereus sp., Ficus nitida, and Mammillaria spp.

17. Trichodorus (probably primitivus), associated with other nematodes in small numbers in soil from citrus, fig, mango, Yunnan and Balladi peaches, peanut, quince.

17a. Trichodorus sp., a short form, female, measuring about 1/2 mm, in soil around plum roots.

18. Triplonchium sp. This nematode was encountered in many soils, but only recently separated and identified. Its occurrence is, therefore, mentioned only from banana, barley, cotton, Kikuyu and St. Augustine grasses.

19. Tylenchorhynchus brevidens Allen 1955, from vetch soil.

19a. Tylenchorhynchus dubius (Buetchli 1873) Filipjev 1936, from vetch and wheat soils.

19b. Tylenchorhynchus magnicauda (Thorne 1935) Filipjev 1936, from soil under peanut.

19c. Tylenchorhynchus maximus Allen 1955, associated with other nematodes in soil under celery, cotton, lettuce, oats, and vulgare wheat.

19d. Tylenchorhynchus parvus Allen 1955, from soil under banana.

19e. Tylenchorhynchus spp. In addition to the identified species this genus was found in soil around a multitude of plants: alfalfa, apple, avocado, barley, bitter almond, carrot, citrus, fig, mango, peach (Shalil and Yunnan), pepper, plum, potato, quince, strawberry, tomato, Kikuyu grass, St. Augustine grass, Bromus sp., Cereus sp., Mammillaria spp., Opuntia depauperata, Urtica sp.

20. Tylenchulus semipenetrans Cobb 1913, on roots of sweet lime (Citrus aurantifolia Swingle var. dulcis) and on sour orange (Citrus aurantium L.).

21. Tylenchus (? costatus), from soil around apple, avocado, banana, fig, guayava, mango, Balladi and Shalil peaches, Marianna plum, quince, rosemary, strawberry, vulgare wheat, Kikuyu and St. Augustine grasses, and Urtica sp.

21a. Tylenchus davainii Bastian 1865, from soil around peanut, Kikuyu and St. Augustine grasses, and Mammillaria spp.

21b. Tylenchus spp., from soil under alfalfa, avocado, banana, barley, celery, citrus, oats, potato, and strawberry.

22. Xiphinema americanum Cobb 1913, was encountered with decline of many plant species, sometimes killing plants like avocado and lavender. It was found with damaged roots and in soil around apple, banana, mango, papaya, peach, plum, Kikuyu and St. Augustine grasses.

22a. Xiphinema krugi Lordello 1955. A few animals, found in soil around a potato plant, very greatly resembled the recently described species (1).

22b. Xiphinema sp. A species not yet identified occurred frequently, sometimes with X. americanum, in soil from a large variety of plants: anona, apple, citrus, fig, mango, Balladi and Shalil peaches, Marianna and Myrobalan 29 plums, quince, rosemary, St. Augustine grass, and Opuntia depauperata.

Non-parasitic nematodes, as far as identified were of the following genera: Acrobeles, Acrobeloides, Boleodorus, Cephalobus, Discolaimus, Labronema, (?)Miranema, Mononchus, Panagrolaimus, Rhabditis, and Tylencholaimus.

The author appreciates the cooperation and guidance of Mr. A. L. Taylor, Mr. Gerald Thorne, and Dr. M. W. Allen. He also thanks Miss Dina Harari and Mrs. Ruth Berger for their assistance.

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RESISTANCE TO BLACK SHANK OF 51 SPECIES OF NICOTIANA AND OF 13 INTERSPECIFIC HYBRIDS

William Lautz[1]

Abstract

Tests of resistance to the black shank fungus, Phytophthora parasitica var. nicotianae, were made on 51 species of Nicotiana and some varieties of and crosses between species. N. longiflora and N. plumbaginifolia were found to be highly resistant; N. undulata, N. nudicaulis, N. exigua, and four others were moderately resistant.

INTRODUCTION

Testing of the more than 50 available species of Nicotiana over the past few years was made in a search for possible sources of resistance to black shank.

H. H. Foster (2), testing 13 species of Nicotiana, found N. repanda, N. rustica, and N. longiflora to have resistance to black shank. R. R. Kincaid (3) reported N. plumbaginifolia and N. repanda to be moderately resistant in field tests. Of 39 species inoculated by Stephen Diachun and W. D. Valleau (1), N. alata, N. bonariensis, N. longiflora, N. nudicaulis, N. plumbaginifolia, and N. repanda were listed as immune.

MATERIALS AND METHODS

The tests herein reported were made over a period of 5 years, testing 1 to 14 species at a time. The fungus Phytophthora parasitica var. nicotianae was grown on cornmeal medium or a corn and oat grain medium for 1 to 2 months; the inoculum was prepared as a spore-mycelium suspension by mixing with water in a Waring Blendor. Although re-isolations were made, the same culture was used in all the tests.

Plants of species and crosses were transplanted into thumb pots at the age of 1 month. After 1 to 2 weeks they were set in an 80° to 90° F temperature case and inoculated with 5 milliliters of inoculum per pot. In each lot, tobacco plants of flue-cured variety 402 which were used as checks were dead within 1 to 2 weeks. A resistant cigar wrapper variety, R. G., and resistant flue-cured varieties, Dixie Bright 101 and D. B. 102, were used as checks with several lots. Surviving plants, when approximately 6 inches high, were placed in 4-inch pots of black shank-infested soil. Seedlings of several species were also inoculated without transplanting, using 25 milliliters of spore-mycelium suspension per pot. The number of plants in each pot varied from 5 to 58. Surviving plants in these pots were handled in the same manner as those inoculated in thumb pots. Seed was obtained from the Nicotiana species collection maintained here. Special acknowledgment is due to Dr. E. E. Clayton, formerly with Field Crops Research Branch, who helped to provide seed of many of the species and F_1 hybrids. Many seed lots were originally supplied by Dr. R. E. Clausen of the University of California at Berkeley.

RESULTS

Tables 1 and 2 show the number of plants of each species inoculated and the percentage surviving after 2 to 3 months. For some species the percentage of plants surviving at the time of transplanting to 4-inch pots, usually 4 to 6 weeks after inoculation, is shown.

N. longiflora and N. plumbaginifolia had outstanding resistance. Other species listed in Table 1 having more than 20 percent survival were N. exigua, N. nudicaulis, N. paniculata, N. repanda, N. rustica brasilia, N. rustica pumila, and N. undulata. Differences between varieties of species were at times marked: N. plumbaginifolia, California lot 51057, had no survivors in a test of ten plants, while the Beltsville and Kentucky collections had high percentages of survival in repeated tests.

Table 3 shows survival of 14 species crosses, 13 with N. tabacum as one parent. Most of

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Table 1. Resistance to attack by Phytophthora parasitica v. nicotiana of 50 species of Nicotiana plants inoculated in thumb pots.

Species	Number of Tests	Number of Inoculations	Percent survival When moved to 4-inch pots	Percent survival At 2 to 3 months
N. acuminata var. acuminata	1	10	0	0
acuminata var. multiflora	1	10	60	10
alata - 2n	2	140	24	0
alata - 4n	2	36	14	3
arentsii	1	20	0	0
attenuata	1	12	0	0
benavidesii	2	30	-	0
benthamiana	1	2	0	0
bigelovii var. multivalvis	2	20	0	0
bigelovii var. quadrivalvis	1	8	0	0
bonariensis	1	20	35	15
clevelandii	2	29	7	0
corymbosa	1	20	0	0
debneyi	1	10	80	0
excelsior	1	16	0	0
exigua	1	40	65	35
forgetiana	2	40	18	15
glauca	1	10	0	0
glauca california	1	20	-	10
corymbo	1	20	-	5
laterita	1	7	-	0
glutinosa	1	7	0	0
goodspeedii	1	10	0	0
gossei	1	10	20	10
knightiana	2	19	-	0
langsdorffii	1	10	0	0
linearis	1	20	0	0
longiflora (Beltsville)	6	160	88	86
longiflora California 50034	3	65	-	69
51039	3	50	-	98
51041	5	90	-	80
maritima	2	18	-	0
megalosiphon	2	25	56	0
miersii	1	50	0	0
nesophila	1	38	37	18
noctiflora	1	20	30	20
nudicaulis	3	113	99	28
occidentalis	1	10	20	0
otophora	1	10	0	0
palmeri	1	10	0	0
paniculata	2	26	-	23
pauciflora	1	20	0	0
petunioides	1	6	0	0
plumbaginifolia (Beltsville)	4	100	-	78
plumbaginifolia California 51057	1	10	100	0
Kentucky 435	3	70	99	73
N. raimondii	2	30	-	0
repanda	2	15	33	27
rotundifolia	2	80	1	0
rustica	1	10	70	0
rustica brasilia	2	29	90	34
rustica pumila	1	8	88	75
rustica Kentucky 4385	1	20	45	5
Kentucky 43054	1	20	100	25
California No.G.106Ky.	1	20	15	5
setchellii	1	10	0	0
solanifolia	2	18	-	0
stocktonii	1	16	69	7
suaveolens	1	30	0	0
sylvestris	2	50	0	0
tomentosa	1	10	0	0
tomentosiformis	1	50	0	0
trigonophylla	1	3	0	0
undulata	1	19	-	53
velutina	1	9	44	0
wigandioides	1	20	0	0
R. G.	3	85	4	1
Dixie Bright 101	3	40	0	0
Dixie Bright 102	1	20	0	0

Table 2. Resistance to attack by Phytophtnora parasitica v. nicotianae of species of Nicotiana plants inoculated in 4-inch pots[a].

Species	Tests-No.	Inoc.-No.	Survival when moved to 4-inch pots-percent	2-3 months survival-percent
N. benavidesii	1	13	-	0
benthamiana	1	29	0	0
bigelovii v. multivalvis	1	20	0	0
v. quadrivalvis	1	17	0	0
clevelandii	1	12	0	0
debneyi	1	26	8	4
glauca	1	27	0	0
glauca california	1	14	-	7
glauca corymbo	1	13	-	15
glutinosa	1	23	0	0
gossei	1	20	0	0
knightiana	1	13	-	15
langsdorffii	1	18	0	0
megalosiphon	1	41	20	5
occidentalis	1	14	0	0
otophora	1	23	0	0
palmeri	1	27	4	0
paniculata	1	8	-	50
raimondii	1	7	-	0
rustica brasilia	1	37	49	14
rustica Kentucky 43054	1	52	10	10
rustica Kentucky 4385	1	22	64	23
setchellii	1	6	0	0
sylvestris	1	18	0	0
trigonophylla	1	5	20	0
undulata	1	20	-	25
velutina	1	58	5	0
Dixie Bright 102	1	191	18	0

[a] These pots are those in which plants were seeded and from which some seedlings were removed.

Table 3. Resistance to Phytophthora parasitica var. nicotianae of 13 crosses between species of Nicotiana.

Cross	Origin of cross	Number of Tests	Number of Inoculations	Percent survival When moved to 4-inch pots	Percent survival At 2 to 3 months
N. debneyi x N. glauca F_1	e	1	10	70	20
N. forgetiana x N. alata F_1	e	2	80	23	1
N. tabacum x N. alata F_1	a	1	20	0	0
N. tabacum x N. benavidesii F_1	a + b	2	110	13	11
N. tabacum x N. otophora F_1	e	1	10	0	0
N. tabacum x N. plumbaginifolia F_1	c	4	50	16	4
N. tabacum x N. setchelli F1	e	1	8	0	0
N. tabacum x N. tomentosa F_1	e	1	47	4	4
4n N. debneyi x N. tabacum F_n	b	1	9	22	0
4n N. tabacum x N. glauca F_n	b	1	10	10	0
4n N. tabacum x N. longiflora F_n	d	4	111	88	18
4n N. tabacum x N. plumbaginifolia F_n	c	3	27	44	0
N. tabacum x N. plumbaginifolia F_2	c	1	79	8	0

[a] L. G. Burk, Plant Industry Station, Beltsville, Maryland.

[b] E. E. Clayton, formerly Plant Industry Station, Beltsville, Maryland.

[c] R. E. Clausen, University of California, Berkeley, California.

[d] W. D. Valleau, University of Kentucky, Lexington, Kentucky.

[e] Beltsville collection.

these showed a low percentage of survival. Two tests were made with N. tabacum x N. benavidesii. In one test 12 out of 20 plants survived 2 to 3 months; in the other, none of 90. Three of the 90 survived 23 days; this indicates some slight resistance.

DISCUSSION

Results of the above tests differ from previous work with regard to several species, probably because of the 80° to 90° F temperature case and the double inoculation. No species was found to be immune.

The crosses between species gave some unexpected results. N. debneyi x N. glauca had a larger percentage of survival than N. debneyi or N. glauca. Only ten plants, however, were used in this test. N. tabacum x N. benavidesii had a survival of 11 percent, more than N. benavidesii alone. N. tabacum x N. longiflora had a much higher survival than N. tabacum x N. plumbaginifolia, even though N. longiflora was only slightly more resistant than N. plumbaginifolia.

At Beltsville, resistance to black shank in breeding lines is obtained from the resistance in N. plumbaginifolia. In Kentucky, emphasis is being placed on sources of resistance from N. longiflora (4). Although other species are not so resistant to black shank as these two, they might be of value as a source of resistance in a breeding program.

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FIELD CROPS RESEARCH BRANCH, AGRICULTURAL RESEARCH SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE

FURTHER STUDIES WITH STREPTOMYCIN ALONE AND IN COMBINATION WITH OTHER CHEMICALS FOR WILDFIRE CONTROL IN BURLEY TOBACCO PLANT BEDS, NORTH CAROLINA, 1956

Luther Shaw, G. B. Lucas, and George F. Thorne, Jr.[1]

Summary

Effective control of wildfire (Pseudomonas tabaci) resulted from six weekly spray applications of streptomycin sulfate at concentrations of 100 ppm and 200 ppm. Following the same schedule streptomycin nitrate gave excellent wildfire control at a concentration of 200 ppm. Dosages of both 3 and 5 gallons of spray per 100 square yards at each application of streptomycin sulfate at 200 ppm concentration gave equally effective control of the disease. The use of glycerin at a concentration of 1-100 in combination with streptomycin sulfate had only slight, if any, beneficial effects on wildfire control; whereas tribasic copper sulfate at a concentration of 3 pounds to 100 gallons of spray in combination with streptomycin sulfate in most cases tended to decrease wildfire control in these tests. The drench and dust formulations with streptomycin sulfate used under the conditions of this experiment did not give effective wildfire control. These results are in general agreement with those obtained in similar tests in North Carolina in 1955.

INTRODUCTION

Wildfire control studies in burley tobacco plant beds were continued at the Mountain Research Station, Waynesville, North Carolina along the same general lines initiated in 1955 as previously reported (5). A brief report of the methods employed and the results obtained in the 1956 studies follows.

MATERIALS AND METHODS

The materials and methods used in 1956 were, in general, the same as those employed in 1955 (5). Variation from the procedures used in 1955 follow. Streptomycin sulfate was again used as the base bactericide in most of the treatments (Table 1). Glycerin, tribasic copper sulfate, and maneb were used in combination with streptomycin sulfate in several treatments. Beneficial effects have been reported from the use of glycerin and certain copper compounds in combination with streptomycin sulfate in the control of certain other diseases (1, 2, 3, 4, 7). Maneb was used in these studies because it is known to be an effective control treatment for blue mold (Peronospora tabacina) and anthracnose (Colletotrichum sp.), and for further tests of its compatibility with streptomycin sulfate.

Each plot involved an area of 27 square feet. The treatments were replicated four times in a randomized block design. The beds were seeded with the Kentucky 16 variety on April 9. All of the beds were inoculated by spraying them with a water suspension of the wildfire parasite (Pseudomonas tabaci) at twilight on the afternoon of May 14. The plants were in the two-leaf stage on this date. The general schedule of treatments listed in Table 1 was begun on the morning of May 15. Subsequent treatments were made at 1-week intervals. Since there was very little evidence of wildfire infections in any of the test plots on June 4, a second inoculation similar to the first was made on the late afternoon of this date. The schedule of treatments was continued, the fourth application being made on June 5. Treatments were continued through June 19, making a total of six applications for most of the treatments, three following each inoculation.

The method used for measuring wildfire development in all plots was the same as that employed by Todd (6) for measuring blue mold severity. For making the disease readings one leaf was pulled from each of 50 plants selected at random in each plot. Each leaf was taken from the midsection of the plant. The leaves from each plot were then classified ac-

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Table 1. Wildfire control with streptomycin alone and in combination with other chemicals in burley tobacco plant beds[a], North Carolina, 1956.

Treatments and concentration	Method of application	Rate per 100 sq. yds.	Number of applications	Disease index June 26
Streptomycin sulfate 50 ppm	Spray	5 gals.	6	10.75
+ glycerin 1-100	"	5 gals.	6	10.81
+ tribasic copper sulfate 3-100	"	5 gals.	6	9.62
+ glycerin 1-100 + tribasic copper sulfate 3-100	"	5 gals.	6	8.56*
Streptomycin sulfate 100 ppm	"	5 gals.	6	6.56**
+ glycerin 1-100	"	5 gals.	6	5.31**
+ tribasic copper sulfate 3-100	"	5 gals.	6	10.12
Streptomycin sulfate 200 ppm	"	5 gals.	6	6.75**
+ maneb 1/2-100	"	5 gals.	6	3.50**
Streptomycin sulfate 200 ppm	"	3 gals.	6	7.81**
	"	5 gals.	7[b]	4.69**
	"	5 gals.	2[c]	12.06
	"	5 gals.	4[d]	6.81**
Streptomycin nitrate 200 ppm	"	5 gals.	6	3.06**
Streptomycin sulfate 50 ppm	Drench	20 gals.	6	9.94
+ glycerin 1-100	"	20 gals.	6	8.06*
+ glycerin 1-100 + tribasic copper sulfate 3-100	"	20 gals.	6	11.75
Streptomycin sulfate 100 ppm	"	20 gals.	6	9.81
	"	10 gals.	6	13.56
Bordeaux mixture 3-4-50	"	25 gals.	4[d]	12.62
Streptomycin sulfate 500 ppm	Dust	3-4 lbs.	6	9.25
+tribasic copper sulfate 7%	"	3-4 lbs.	6	13.56
Streptomycin sulfate 1000 pm	"	3-4 lbs.	6	14.56
None (Check)				13.06
L.S.D. .05				3.96
.01				5.25
C.V. (%)				36

[a] See text for methods employed.

[b] The first application was made 7 days before the first inoculation.

[c] One application was made immediately following each inoculation.

[d] Two applications were made beginning immediately after each inoculation.

* Significant over the check at the 5% level.

** Significant over the check at the 1% level.

cording to disease severity, using the following scale:

Class	Description	Index value
0	No wildfire infections	0
1	Very slight (1 to 25% of leaf area affected)	12 1/2
2	Slight (26 to 50% of leaf area affected)	25
3	Moderate (51 to 75% of leaf area affected)	50
4	Severe (76 to 100% of leaf area affected)	100

These data were then converted to a wildfire index by multiphying the number of leaves in each class by the respective index value, summing the products, and dividing by the total number of leaves examined. Hence, the index values represent the extent of wildfire damage on a percentage basis.

RESULTS

Weather conditions during the first 3 weeks that this experiment was in progress were very unfavorable for wildfire development; however, during the last 3 weeks frequent light precipitation created moderately favorable conditions for the disease. Wildfire lesions were generally prevalent in the untreated and in some of the treated plots within 2 weeks following the second inoculation. The extent of damage only occasionally reached the moderate stage, however. Disease readings were made on all plots on June 26, which was 6 weeks after the first inoculation and 3 weeks after the second.

The results from the analyses of the disease index readings in this experiment show (Table 1) that when used alone in six applications at weekly intervals streptomycin sulfate gave satisfactory control of wildfire only in the spray formulations at concentrations of 100 ppm and 200 ppm. Streptomycin sulfate used alone did not give effective control when applied at a concentration of 50 ppm as a spray, 50 ppm and 100 ppm as a drench, or 500 ppm and 1000 ppm as a dust.

The use of glycerin at a concentation of 1-100 in combination with streptomycin sulfate tended to increase disease control slightly, in both the spray and drench formulations, although in no case did the addition of glycerin significantly increase disease control over that obtained with streptomycin sulfate alone.

Tribasic copper sulfate used in combination with streptomycin sulfate in spray, drench, and dust formulations tended in most cases in this test to reduce disease control in comparison with streptomycin alone at comparable concentrations.

Although maneb in combination with streptomycin sulfate did not give significantly better wildfire control than did streptomycin sulfate alone, these tests strongly indicate that the two materials are compatible in a spray mixture on burley tobacco.

Dosages of 5 gallons and 3 gallons per 100 square yards at each application of streptomycin sulfate 200 ppm in spray formulations gave equally effective wildfire control.

The treatments involving varied numbers of applications of streptomycin sulfate (200 ppm) sprays were somewhat confused by inoculation of the beds with the wildfire organism at two dates in the course of the experiment. It is, however, of interest to note that seven applications, the first being made 1 week before the first inoculation, gave somewhat better wildfire control than did six applications beginning immediately after the first inoculation. One application following each inoculation did not control the disease. On the other hand, two applications following each inoculation did give effective disease control. It is questionable whether this would have been the case had conditions been more favorable for wildfire development.

Spraying with streptomycin nitrate at a concentration of 200 ppm gave excellent wildfire control. Bordeaux mixture (3-4-50) used as a drench did not control the disease in this experiment.

It should be noted that only traces of wildfire were observed in the beds where significant disease control was indicated by the disease-index readings. The plants in these beds were judged by the authors to be safe for transplanting to the field.

Neither blue mold nor anthracnose infections were observed in these beds, thus it was not possible to measure the effectiveness of the maneb-streptomycin combination in the control of these two diseases.

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CHEMICAL CONTROL OF STRAIGHTHEAD IN RICE

N. S. Evatt and J. G. Atkins[1, 2]

SUMMARY

In 1956 several chelated compounds, together with a soil amendment material called Feralum, were applied, in separate tests, to the straighthead-susceptible Century Patna 231 variety of rice grown under conditions favorable for disease development on Hockley fine sandy loam near Eagle Lake, Texas. No benefits from the chelated materials were noted but highly significant yield differences were obtained from Feralum which were attributed to differences in severity of straighthead.

INTRODUCTION

Previous reports indicate straighthead is one of the more destructive diseases of rice in the Southern States (5). No causative organism has been associated with the disease, hence it is considered physiological. The disease is readily identified by sterile, malformed florets and glumes and consequent erect panicles. Previous work indicates that draining at the proper time or the use of resistant varieties are feasible methods for the control of straighthead (4, 5). Leading varieties have been adequately cataloged according to susceptibility (1), and the correct time of draining has been fairly well established (2, 5). Green and Stoner (3) reported in 1952 that iron compounds corrected disorders of rice grown on muck soils of the Florida Everglades. Straighthead apparently was involved in these disorders. However, no consistent or practical chemical control on mineral soils has been reported.

Unpublished data[3] from an off-station field test in 1941 show improved yields and less straighthead from the application of several minor elements to the soil on which the Blue Rose variety of rice was grown. One set of plots received 20 pounds potassium permanganate, 20 pounds boric acid, 50 pounds ferric sulfate, 10 pounds copper sulfate, and 20 pounds zinc oxide per acre together with 20-40-20 fertilizer. The other plots received only the 20-40-20 fertilizer. The plots receiving the minor elements yielded 17 barrels per acre, whereas those those receiving only the 20-40-20 fertilizer yielded only 12 barrels per acre. This statistically significant yield increase was attributed to less straighthead but no further experiments were conducted at that time.

EXPERIMENTAL PROCEDURE

Century Patna 231 was drill seeded April 27, 1956 in an experimental test area on Hockley fine sandy loam soil near Eagle Lake, Texas. The area was kept flooded from 34 days after seeding until harvest. Soil and foliar application of the chelated materials were tested in 6 x 30-foot plots in complete randomized blocks with four replications. The materials were applied to the soil just prior to flooding at rates of 30, 75, or 120 gms each of iron and zinc; and 20, 40, or 80 gms of Versenol powder. Foliar treatments were applied at the rate of 1/2 gallon per plot at concentrations of 50, 100, 500, or 2000 ppm of Disodium Versenate before flooding and 50, 150, or 300 ppm iron; 20, 60, or 180 ppm zinc; and 20, 60, or 80 ppm manganese 74 days after seeding. Each material was combined with a wetting agent in order to insure even distribution.

Feralum was tested in another experiment using 0, 1000, or 2000 pounds per acre on plots in randomized blocks with four replications. The material was distributed uniformly by hand over the soil prior to flooding. Feralum, a chemical by-product, has the following

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[2] Appreciation is expressed to David Winterman and Mose Thomas, Eagle Lake, Texas, for furnishing the land, water, and land preparation for these experiments. We are indebted to Stauffer Chemical Company, Houston, Texas, for the Feralum and to Dow Chemical Company, Midland, Michigan, for the chelated materials.

[3] Annual Report for 1941 on file at the Rice - Pasture Experiment Station, Beaumont, Texas.

composition: 29.86% ferric sulfate, 2.74% ferrous sulfate, 33.32% aluminum sulfate, 1.58% titanium sulfate, 10.76% free sulfuric acid, 10.16% insolubles, and 11.58% water.

RESULTS

No observable effects of the chelates were noted. An estimated 75 percent or more of the plants in all plots were affected by straighthead. No yields were recorded.

Highly significant yield differences were obtained in the Feralum test as shown in Table 1.

Table 1. Effect of Feralum on straighthead and yield of rice.

Treatment	Straighthead (Class)	Yield per acre* Pounds	Barrels	Percent Increase
None	5	1552	9.58	---
Feralum, 1000 lbs./A	3	2793	17.24	80
Feralum, 2000 lbs./A	2	3439	21.23	122

L.S.D. .01 = 4.37 barrels per acre.

* 14 percent moisture basis.

Visual differences between plots treated and not treated with Feralum were apparent. The percentage reduction in yield due to straighthead was estimated prior to harvest by a numerical rating scale of 1-5, inclusive. Each successive number comprised a 20 percent range in reduction. A correlation coefficient of -0.99 between estimated percentage reduction in yields due to straighthead and actual yields shows that the estimates were very accurate. Had the experimental area been drained at the recommended time, it is estimated the acre yield would have been at least 24 barrels.

It is difficult to attribute the results with Feralum to any particular element. A causal analysis would place emphasis on iron nutrition; but heavy additions of sulfur and aluminum were also made. Also, a change in the availability of an existing soil element or elements might have occurred. Applications of Feralum are not considered to be economically practical at present. However, the results of this preliminary test provide valuable leads for future work, since the compounds in this material can be applied separately by different methods and on different dates.

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COOPERATIVE INVESTIGATIONS OF THE TEXAS AGRICULTURAL EXPERIMENT STATION AND FIELD CROPS RESEARCH BRANCH, AGRICULTURAL RESEARCH SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE

UNIFORM RICE SEED TREATMENT TESTS IN ARKANSAS, LOUISIANA AND TEXAS, 1955-56

J. G. Atkins, E. M. Cralley and S. J. P. Chilton[1, 2]

Rice seed treatment using one of several fungicides has become a standard practice in the southern rice States of Arkansas, Louisiana, and Texas within the past 10 years. Certain chemicals have been recommended and used for the control of seedling blight caused by seed- or soil-borne fungi because they provided a measure of "stand insurance" at relatively low cost.

FUNGI AND FACTORS INVOLVED IN RICE SEEDLING BLIGHT

Several seed- and soil-borne fungi cause rice seedling blight by invading the seedling both before and after emergence from the soil. The principal seed-borne pathogens are: Helminthosporium oryzae, Curvularia spp. and Fusarium spp. Rhizoctonia solani, Fusarium spp., and Pythium spp. are the most important soil fungi involved in rice seedling blight. In 1937 Cralley and Tullis (5) summarized an extensive study of rice seedling blight. They found that the frequency with which Pythium spp. and H. oryzae are isolated varies greatly between collections. In a study of the fungi present on discolored rice kernels Tullis (13) frequently isolated the following, which seem to be of little importance as seedling pathogens: Phoma spp., Trichoconis caudata, Cladosporium herbarum, Helicoceras oryzae, and Nigrospora oryzae.

Godfrey (7) and later Tisdale (12) in 1922 investigated an organism in the Mycelia sterilia group as a cause of seedling blight. Tullis (13) later considered this fungus to be Trichoconis caudata.

The amount or severity of seedling blight is influenced primarily by: 1) Soil temperature, i e., time of seeding; 2) soil moisture; 3) infestation of the seed by fungi; and 4) depth of seeding. For many years rice farmers have experienced more difficulty with seedling blight early in the season. In the various rice seed-treatment studies (1, 2, 10) the more effective fungicides gave larger stand increases on rice sown early in the season than they did on rice sown late in the season. Cralley and Tullis (5) reported seedling blight to be more severe at 18° C than at higher temperatures, on the basis of greenhouse tests in which the soil temperature was regulated. At the lower temperatures two of the most important seedling blight organisms, Helminthosporium oryzae and Pythium sp., were isolated more frequently than at higher temperatures. Also, at the lower temperatures severely blighted seed (produced at Crowley, Louisiana) gave more diseased seedlings than a lot of clean seed (produced at Stuttgart, Arkansas). At the higher soil temperatures Fusarium spp. were found to be relatively more important. Ocfemia (8) found seedling blight to be favored by lower soil temperatures.

PREVIOUS WORK AND PRESENT STATUS OF RICE SEED TREATMENTS

In 1922 Tisdale (12) reported that the hot-water treatment was effective in eliminating fungi from seed rice but he did not recommend the treatment. Cralley and Tullis (5) compared copper oxide, formaldehyde, and ethyl mercury phosphate as to effect on emergence, severity of disease, and fungi involved on different seed lots in field and greenhouse tests, and as to yield in field tests. In certain of the tests the treatments resulted in better emergence but the yields were not always increased accordingly. Of the three treatments, ethyl mercury phosphate was the most effective against Helminthosporium oryzae. On the basis of the work reported in 1937, Cralley and Tullis (5) concluded that "seed treatments cannot be recommended for the control of rice seedling blight in Arkansas until more positive data are available".

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[2] The writers acknowledge the assistance of Dr. T. H. Johnston, Mr. Nelson E. Jodon and Mr. H. M. Beachell, Research Agronomists, Field Crops Research Branch, Agricultural Research Service, United States Department of Agriculture, located, respectively, at the Rice Experiment Stations of Arkansas, Louisiana and Texas.

In 1947 Cralley (3) in Arkansas found Arasan and Phygon to be effective as rice seed treatments. In Louisiana Chilton and Ryker in 1947 (2) recommended the use of Arasan (dust treatment) after testing various materials at relatively high dosages. They found Arasan to be slightly better than Spergon and markedly better than New Improved Semesan, Jr. Arasan gave stand increases of approximately 25 percent in March and April seedings and 12 percent in May. Shortly afterwards Ryker (10) reported that Arasan gave an average stand increase of 25 percent in a test involving drill-sown rice on 15 farms and that Arasan SF (slurry application) and Arasan were equally effective.

Cralley and French (6) in 1951 concluded that Ceresan M was more effective than Arasan in controlling Helminthosporium oryzae. In 1948, Atkins (1) reported that Arasan gave more consistent results than did Dow 9B, Spergon, or Phygon at relatively high dosages. Cralley (4) in 1955 reported that Arasan SF-X and Ceresan M gave the highest average stand counts of the materials tested over a 3-year period. However, Panogen, Agrox, and captan were considered promising.

Cralley (3) and Chilton and Ryker (2), in their 1947 recommendations, apparently envisaged a safe dust treatment for usage by individual farmers, involving simple, perhaps homemade, application equipment. However, the introduction of slurry seed-treatment machines, and fungicides designed for use in such machines into the rice area essentially changed rice seed treatment into a custom operation. Today in the rice seed trade treating machines are used in conjunction with modern seed-cleaning and grading equipment. Thus, treatment of the seed rice with a fungicide in a relatively large seed-processing plant has become a standard practice in the preparation of pure, high-quality premium-grade seed rice. In recent years the demand for quality seed rice, of certified or higher grade, has tended to establish the use of seed-treatment fungicides as a routine practice.

The widespread use of seed-treatment machines operated by trained personnel, following specific experiment-station or manufacturer recommendations, has largely eliminated the possible overdosage of the seed. Perhaps as a consequence, certain mercury fungicides found to be effective have been recommended and given satisfaction in recent years.

THE UNIFORM SEED TREATMENT TEST, 1955-1956

Materials and Methods

Clean, good-quality seed rice of two representative varieties was used for these tests. These were Zenith, a medium-grain type with pubescent (rough) hulls, and Bluebonnet 50, a long-grain type with smooth hulls. The chemicals tested were, with a few exceptions, current production samples provided for experimental testing.

Treatment Procedure: -- Sufficient seed for the test was weighed and placed in large glass jars with screw caps. All materials, except those for the direct-treatment method, were used as slurry treatments. The respective slurry mixtures were prepared so that the same volume of mixture was used for each fungicide. The calculated amount of each chemical was carefully weighed and mixed in water without sticking or other agents unless suggested by the manufacturer. The slurry mixture was added to the weighed sample of rice seed in the glass jars and thoroughly shaken in order to obtain good distribution over the seed. The treated seed was held in closed paper bags for at least 48 hours prior to packaging in coin envelopes in preparation for seeding. Certain of the materials used as direct treatments, such as Panogen 15, were handled in a similar manner except that they were not mixed with water.

Location of Tests, and Soil Types: --

1. Rice Experiment Station, Crowley, Louisiana. Crowley silt loam.
2. Rice Branch Experiment Station, Stuttgart, Arkansas. Crowley silt loam.
3. Rice-Pasture Experiment Station, Beaumont, Texas. Beaumont clay.

Seeding Dates: -- Two seeding dates were used each year for all treatments, varieties, and locations, but the dates were not uniform as to locations and years. The first seeding was made as early as practical, generally early March at Beaumont and Crowley and late March at Stuttgart. The second seeding was made 4 to 6 weeks later.

Seeding Methods, Rates, and Culture: -- The tests were sown with small-plot equipment under conditions similar to drill-sown rice. The row length varied, but generally 20-foot rows were used. After the rice seedlings emerged all plants in each row were counted.

Results

A summary of the tests for 1955 and 1956 is given as Table 1. The results are given as over-all averages for the materials at the dosages tested, instead of as a more detailed listing by locations, years, varieties, and seeding dates. In certain specific tests considerably higher stand increases resulted from the use of a number of materials. For example, in the first seeding of Bluebonnet 50 at Crowley, Louisiana in 1956, stand increases of essentially 100 percent were given by Ceresan M, Ceresan M-2X, Agrox, Panogen 15, MEMA, and Ceresan 200.

In general each of the fungicides tested increased emergence. However, on the basis of Table 1 and an inspection of the data for individual series, certain materials were more consistent in giving higher stand increases than others.

In 1956 differences were encountered between the two varieties, Zenith and Bluebonnet 50, as to the response from the mercurials and non-mercurials. The two groups were essentially equal on Zenith but the mercurials were markedly superior on Bluebonnet 50. The seed lot of Bluebonnet 50 (from the Beaumont station) was rather heavily infested with Helminthosporium oryzae, while the Zenith seed lot (from the Stuttgart station) was not.

Table 1. Summary of 1955 and 1956 uniform rice seed treatment tests. Figures represent percentage emergence based on averages of stand counts for the 3 locations.

		1955				1956					
		ZENITH		BLUEBONNET 50		ZENITH		BLUEBONNET 50		Percent Increase	
Fungicide	Dosage (oz./bu.)	1st.	2nd. (Seeding)	1st.	2nd.	1st.	2nd. (Seeding)	1st.	2nd.	1955	1956
Arasan SFX	1	62	87	44	65	61	62	44	55	14.7	14.0
Delsan	1-1/8	71	85	38	66	60	68	41	61	15.6	19.0
Spergon-SL	1	66	80	42	64	53	62	44	58	11.9	12.4
Phygon-XL	1	64	81	47	63	54	61	50	56	13.8	14.9
Dow 9B	1	65	73	42	57	49	55	48	58	11.0	9.9
Orthocide 75	1	63	83	43	66	53	65	40	52	12.8	8.3
Captan 75	1	62	79	43	67	53	56	44	56	11.9	8.3
Yellow Cuprocide	1	64	83	40	63	60	68	41	59	11.0	11.6
Ceresan M	1/2	65	73	43	66	56	60	61	65	10.1	25.6
Ceresan M-2X	1/4	64	78	44	67	53	52	59	65	12.8	19.0
Ceresan 200	1/4	--	--	--	--	53	60	60	64	----	22.6
Agrox	1/2	65	81	46	65	55	61	56	66	14.7	24.0
Panogen 15	1/2	66	78	46	65	54	62	62	68	13.8	20.7
MEMA	1/4	67	81	45	68	57	67	56	64	16.5	27.3
MEMA	1/6	62	83	47	69	60	66	56	65	16.5	28.1
Control	---	60	70	38	57	50	54	37	52	----	----

DISCUSSION

Considerable variation in relative performance of the various fungicides was encountered in the tests. The data for previous tests (1, 2, 3, 4, 10) indicate a similar variation. While the stand increases given by certain fungicides were unusually high (up to 100 percent) in certain instances, the stands were sometimes rather low. Such variation is to be expected on the basis of the factors influencing the severity of rice seedling blight as listed at the beginning of the article. The results obtained confirm previous reports as to the superiority of the mercury fungicides for combating Helminthosporium (5, 6).

The stand increases given by Agrox, Ceresan M and M-2X, Panogen 15, and MEMA varied from outstanding to marked improvement. Certain of the non-mercurials, such as Arasan SFX, Delsan AD, and Phygon-XL gave consistent stand increases.

Some of the materials tested have been recommended for seed treatment of rice. These are Arasan (2, 3, 9, 10, 11, 14, 15), Phygon-XL (3), Ceresan M (9, 11, 14, 15), Yellow Cuprocide (9, 14, 15), Spergon-SL (9, 14) and Dow 9B (14, 15).

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A NEW DISEASE SYMPTOM INCITED BY THE OAT LEAF BLOTCH PATHOGEN, HELMINTHOSPORIUM AVENAE

H. H. Luke, A. T. Wallace and W. H. Chapman[1]

Oat leaf blotch (Helminthosporium avenae Eidam) is generally considered as a minor disease (1, 2, 5) but it occurred in epiphytotic proportions throughout Florida and south Georgia during the spring of 1956. During this outbreak, severe sheath and culm infections were observed. To the knowledge of the authors, sheath and culm invasion has not been previously reported and is considered as a new disease symptom incited by this pathogen. This new manifestation caused a "black-stem" symptom somewhat similar to the oat black stem disease incited by Septoria avenae (3, 4).

Leaf symptoms, which departed somewhat from those normally observed, were characterized by large atypical lesions that evolved from small brownish water-soaked spots. These lesions coalesced into linear reddish-pink blotches with poorly defined margins and dark centers. In some cases, lesions developed into dark brown necrotic blotches, giving the plants a scorched or severely blighted appearance. As the disease progressed, infection moved from the leaf base to the sheath. Sheaths first became reddish-pink followed by a dark brown to black discoloration. The moist condition created by the close association of leaf sheath and culm enhanced disease development; consequently, infection spread rapidly to the culm proper and large black necrotic areas encircled this portion of the plant. These black-stem infections were more pronounced near nodal regions, where sheaths are in close contact with the culm. Infection in severe cases extended through the culm and white wefty mycelium appeared in the culm cavity (see Figure 1). Occasionally, severe culm infection was followed by breaking of the stem at the third or fourth internodal region.

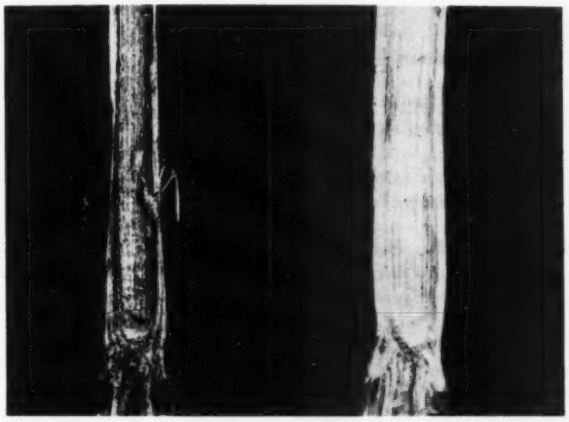

FIGURE 1. Culms of Southland oat variety showing (left) the effect of invasion by Helminthosporium avenae, and (right) a healthy culm.

Material exhibiting the "black-stem" symptoms described was collected from seven locations throughout Florida and three locations in south Georgia[2]. Isolations were made from leaves, sheaths and culms. Transfers were made directly to agar plates with fungal mats found in the culm cavity. Approximately 85 percent of the fungi isolated from leaves, sheaths and culms proved to be H. avenae, while 97 percent of the isolates from the culm cavity were H. avenae[3].

Isolation data suggested H. avenae as the causal agent of sheath and culm infection;

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[2] The writers are indebted to Dr. D. D. Morey, S. A. Param, and F. G. McGill of the Georgia Coastal Plain Experiment Station for disease specimens and reports on disease incidence and damage.

[3] Acknowledgment is extended to Dr. E. S. Luttrell for identification of the causal organism.

therefore, two cultures isolated from each of the four plant parts listed above were prepared in a conventional manner. Foliage of the oat varieties Southland, Victorgrain 48-93, Floriland, Andrew, and Seminole was inoculated with these cultures when the plants were approximately 4 weeks old. This inoculation procedure is described elsewhere (2). Ten days following inoculation, leaves were observed for leaf blotch symptoms. Seven cultures showed varying degrees of pathogenicity on all varieties, while one isolate appeared to be pathogenic only on Southland. With one exception, isolates taken from culm tissue and the culm cavity were found to be pathogenic on all varieties. Three of these isolates, when placed on Southland, incited black-stem symptoms typical of the condition observed in the field during the spring of 1956. One isolate invaded the culm of Victorgrain 48-93. Reisolation from the blackened culms of these varieties yielded a high percentage of H. avenae cultures; thus the evidence at hand strongly suggests that this pathogen is the causal agent of a new black-stem symptom described herein.

This epiphytotic was first observed at Belle Glade, Florida during the middle of February and later as far north as Experiment, Georgia. Although severe infection occurred over a wide area, this disease was most prevalent in northwest Florida and south Georgia. In this area many farms experienced a reduction of 60 percent of normal yield, and a number of large plantings of the Southland variety were completely destroyed. Southland was observed to be more severely damaged than other varieties; however, Seminole, Victorgrain 48-93, and Arlington exhibited varying degrees of infection, including culm invasion. In general, Seminole and Floriland appeared to be more resistant than the other varieties but were severely infected when planted on land that had been sown with oats the previous year.

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FIELD CROPS RESEARCH BRANCH, AGRICULTURAL RESEARCH SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE, AND FLORIDA AGRICULTURAL EXPERIMENT STATIONS COOPERATING (GAINESVILLE AND QUINCY, FLORIDA)

A CORK BORER TECHNIQUE OF INOCULATING CORN PLANTS WITH STALK-ROT FUNGI[1]

Lansing E. Williams and S. K. Menon

Summary

Toothpick, infested thread, hypodermic, and cork borer fungus-agar disc methods of inoculating corn stalks with stalk-rotting fungi were compared. All methods of inoculation resulted in sufficient stalk rot for comparisons of the resistance of field corn hybrids to stalk rot and of the relative pathogenicity of fungal isolates. The cork borer method was selected for large-scale field inoculations because of the ease of preparation of inoculum and rapidity of inoculation procedures.

INTRODUCTION

The need for an efficient method of inoculating corn stalks with potential stalk-rotting micro-organisms is imperative, if a large-scale study of stalk rot resistance in corn or of the pathogenicity of a large number of fungal isolates is attempted. Several stalk-inoculating methods have been used in previous studies. The most common of these have been the injection of conidial suspensions into the stalk with a hypodermic syringe (1, 2, 3), and the insertion of fungus-infested pipe cleaners (5) or wooden pegs (6) into the stalk. Several stalk-inoculation methods were compared, and the data are reported in this paper.

METHODS

Three strains of Fusarium roseum f. cerealis (Cke.) Snyder & Hansen (4), and one strain of Diplodia zeae (Schw.) Lév. were used as test isolates. The culture medium used was a glucose-yeast extract-phosphate medium of the following composition per liter: 6 gm glucose, 3 gm yeast extract, and 1.5 gm potassium dihydrogen phosphate. Agar was added when desired. Wooden pegs (toothpicks) were boiled in water, inserted into the culture medium, and infested with the fungus isolate according to the method of Young (6). Conidial suspensions were prepared by scraping test-tube slants of the isolates with a transfer needle. Infested twine strings were prepared by soaking lengths of twine in the liquid medium, then placing them on agar plates subsequently infested by a conidial suspension of the test fungi. For removal of agar-fungus discs with cork borers, agar plates were inoculated with mycelial fragments.

Corn plants at the silking stage were inoculated in the center of the internode above the internode bearing the ear. The wooden toothpicks were inserted diagonally downward into holes punctured with an ice-pick. One ml volumes of the conidial suspensions were injected into the stalks through a 1 ml no. 1YT Tuberculin Syringe equipped with a no. 16 needle. Infested strings were inserted through the stalks with a large size darning needle, then cut with scissors on each side of the stalk. Stalks were inoculated with the fungus-agar discs by inserting a cork borer (outside diameter 0.6 cm) into stalks and removing a plug of tissue, then inserting the borer with the tissue inside into the fungus plate, and finally reinserting both host and fungus tissue back into the original hole by ejection with the cork borer ramrod.

Data were taken 12 to 14 days after inoculation, and the severity of stalk rot was estimated by the use of the following scale:

1/2 Trace of rot at the point of inoculation.
1 Approximately one-fourth of the inoculated internode necrotic.
2 Approximately one-half of the inoculated internode necrotic.
3 Approximately three-fourths of the inoculated internode necrotic.
4 All of the inoculated internode necrotic.
5 Necrosis extending into an uninoculated internode.

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[1] Published with approval of the Director of the Agricultural Experiment Station as Journal Article No. 80-56.

RESULTS

Greenhouse: The toothpick, infested thread, cork borer, and hypodermic methods of inoculation were studied in the greenhouse using field corn, Ohio Hybrid W 49, as the host plant.

In the first experiment, two isolates of F. roseum were used in the comparisons and the data are summarized in Table 1. The severity of stalk rot was least with the toothpick inoculations, with no significant differences between the other methods. The isolates of F. roseum differed in their pathogenicity; the fungus x method interaction was not significant.

In another experiment, the methods were compared using a third isolate of F. roseum and an isolate of D. zeae. Data from this study are summarized in Table 2. Inoculations by the hypodermic method resulted in less stalk rot than inoculations by the infested thread and toothpick methods. Data from the cork borer inoculations did not differ significantly from data of the latter two methods. There were no significant interactions. A photograph of stalks inoculated by the cork borer method appears in Figure 1.

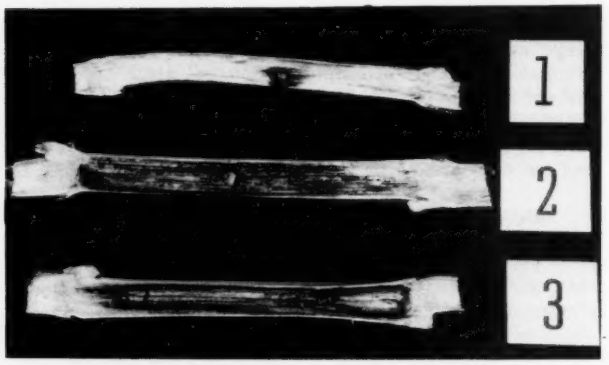

FIGURE 1. Corn stalks inoculated by the cork borer fungus-agar disc method. 1--check, 2--F. roseum, and 3--D. zeae.

Field: The cork borer method of stalk inoculation was used in several field experiments in studies of stalk rot resistance in field corn hybrids, and studies of the relative pathogenicity of fungal isolates. A portion of the data from these studies is summarized in Table 3. Through the use of this method of inoculation differences in the stalk rot resistance of hybrid corn as well as differences in the relative pathogenicity of fungal isolates could be determined.

DISCUSSION

The comparison of the toothpick, infested thread, hypodermic, and cork borer types of stalk inoculation showed that all these methods were effective in inducing stalk rot of field corn hybrids. In one experiment the toothpick method induced the least amount of stalk rot; whereas, in another it induced the most severe rot. The hypodermic method of inoculation resulted in the least amount of rot in one experiment. Generally, the cork borer agar-disc inoculations were intermediate in their reaction.

In this study inoculations by any one of these methods of inoculation induced enough rot for use in experiments to study stalk-rot resistance in field corn hybrids and the relative pathogenicity of fungal isolates. Also, the relative pathogenicity of fungal isolates remained the same regardless of type of inoculation.

The adoption of a particular inoculation method would entail evaluation of the amount of time required for preparing the inoculum and subsequent inoculations. The preparation of inoculum for the cork borer method involves the inoculation of agar-plates only. As for time spent per stalk inoculation, the cork borer is also most efficient, requiring only 5 to 10 seconds per inoculation. Cork borer stalk inoculations in greenhouse and field experiments demonstrated that differences between field corn hybrids in susceptibility to stalk rot could be detected, as well as differences in the relative capacity of fungal isolates in inducing stalk rot. As sporulation is of no consequence, any culture medium supporting mycelial growth could be selected by the experimenter. Increasing the proportion of agar from 2 to 4 percent in the culture medium facilitated removal of the agar discs with ease.

Table 1. Comparison of different methods of stalk inoculations in inducing stalk rot of hybrid corn plants in the greenhouse.

Fungus isolate	Index[a] of stalk rot from indicated method of inoculation				
	Toothpick	Infested thread	Cork borer	Hypodermic	Mean
F. roseum no. 20	0.8	1.8	1.6	2.0	1.6
F. roseum no. 206	1.7	2.4	3.2	2.5	2.5
Mean	1.3	2.1	2.4	2.3	

[a] Index derived as the mean of the ratings of 12 plants. LSD for inoculation method at the 0.5% level was 0.5; at the 0.01% level, 0.7. LSD for fungal isolate at the 0.5% level was 0.4; at the 0.01% level, 0.5. No significant interactions.

Table 2. Comparison of different methods of stalk inoculations in inducing stalk rot of hybrid corn in the greenhouse.

Fungus isolate	Index[a] of stalk rot from indicated method of inoculation				
	Toothpick	Infested thread	Cork borer	Hypodermic	Mean
F. roseum no. 212	3.0	3.0	2.8	2.3	2.8
D. zeae	4.3	3.7	3.6	3.0	3.7
Mean	3.7	3.4	3.2	2.7	

[a] Index derived as the mean of the ratings of 12 plants. LSD for inoculation method at the 0.05% level was 0.6; at the 0.01% level, 0.8. LSD for fungal isolate at the 0.05% level was 0.4; at the 0.01% level, 0.6. No. significant interactions.

Table 3. Severity of rot in stalks of dent corn hybrids inoculated in the field by the cork borer method.

Fungus isolate	Index[a] of stalk rot in indicated hybrids					
	Iowa 4376	Iowa 4249	Indiana 252 A	A.E.S. 805	Ohio K 35	Mean
F. roseum no. 212	2.2	1.4	1.9	1.7	2.4	1.9
F. roseum no. 206	2.9	2.2	2.5	3.0	2.8	2.7
D. zeae	4.3	3.8	4.3	3.4	4.5	4.1
Mean	3.1	2.5	2.9	2.7	3.2	

[a] Index derived as the mean of the ratings of 4 replicates of 20 plants each. LSD for fungal isolates at the 0.05% level was 0.7; at the 0.01% level, 0.9. LSD for corn hybrids at the 0.05% level was 0.4; at the 0.01% level, 0.5. No. significant interactions.

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PHYSIOLOGIC RACES OF THE LEAF RUST OF WHEAT IN THE UNITED STATES IN 1955[1]

C. O. Johnston and M. D. Huffman[2]

Collections of the leaf rust of wheat, Puccinia rubigo-vera (DC.) Wint. f. sp. tritici (Eriks.) Carleton, from 30 States were analyzed for their physiologic race content. Only collections made during the crop season of 1955 and the ensuing fall (ending December 31, 1955) are included in this report. A total of 285 collections were studied. They yielded 933 isolates.

The data obtained are summarized in Table 1. It is well known that certain physiologic races of leaf rust are similar to other races and sometimes are indistinguishable from them. Similar races, therefore, frequently are grouped together under the unified race numbers agreed upon in 1950. That procedure is followed in this report which shows the unified numbers and the constituent race numbers in Table 1.

Although a total of 22 races representing ten unified races were isolated, it is obvious from the data that only about six races representing four unified races were abundant and widely distributed in the United States in 1955. The most abundant race was 5, which comprised 26.9 percent of all isolates and appeared in all States. Race 105, representing UN 6, was second in prevalence, although race 15 of UN 2 was almost equal. Race 105 occurred in all but the northwestern area and in all but 6 States. The similar race 6 exhibited a surprising increase in prevalence in 1955. This group of races (UN 6) is very important because its members attack the variety Kenya Farmer which is being widely used in breeding programs in the United States.

Race 15 also was very important in 1955, especially when considered with the similar race 2. Race 15 was third in prevalence and occurred in all areas and all but 2 States.

UN 13 was fourth in prevalence with constituent races 54 and 122 of nearly equal importance. Both of those races occurred in all but the northwestern area and at several stations in each area. Race 35 was isolated much less frequently from 1955 collections than from 1954 collections. On the other hand, race 77 was isolated more frequently in 1955 than in other recent years.

UN 9 was somewhat more prevalent in 1955 than in 1954, although the group remains relatively unimportant when compared with some other races. Race 19 was the most important race in the group in 1955.

UNITED STATES DEPARTMENT OF AGRICULTURE, FIELD CROPS RESEARCH BRANCH, AGRICULTURAL RESEARCH SERVICE, AND THE KANSAS AGRICULTURAL EXPERIMENT STATION

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Table 1. Physiologic races of Puccinia rubigo-vera tritici in the United States in 1955.

Geographic and crop area, and State	Number of isolates for unified races and constitutent physiologic races.																								Total number		
	2		3	5		6				9				10		11	13				14	17			
	2	15	58	5	52	6	28	105	126	9	10	13	19	11	131	93	35	54	77	122	50	45	Isolates	Races	Collections
NORTHEASTERN, SOFT WINTER																											
Arkansas	2	1		8		1							1					3	1	2	1		19	9	6
Illinois		1	4	2		2		5	1	1								3					20	8	6
Indiana		4	9	8				4					3					4	1	3			36	8	11
Michigan	2	4	12	11		2	3	12	6	1	1						1			5			60	12	15
Missouri		7		5		1		1	4				1				1	2		5	1		28	10	8
New York		3	8	2	1			3					1										18	6	6
Ohio		1	1	7		2		1	1								2	3		2			20	9	7
Pennsylvania		1	1	1		1																	4	4	1
SOUTHEASTERN, SOFT WINTER																											
Alabama	1	3	2	3		1			3														13	6	6
Florida	2	6	2	19		5	3		3		1		2					5	2	3		1	54	13	15
Georgia		2	2	6				3	1				2					8					24	7	7
Louisiana		1	1	2																			4	3	2
Mississippi		4		13		3		3	1				2					4		1			31	8	10
N. Carolina			2	6				1										1					10	4	3
S. Carolina	1	4	1	12		3	2	16	7		1			1				4	1	7			60	13	17
Tennessee		2		3				3	1							2	2			2			15	7	4
Virginia	1	5		5		2	1	3					1					1		1			20	9	7
CENTRAL, HARD RED WINTER																											
Colorado		3		3		1		1					1							1			10	6	4
Kansas	24	6	1	29		15	4	3	3	1			1	4	1				2	8		2	104	15	34
Nebraska		1	1	5		5							3					1					16	6	7
New Mexico	8	7		7		5	1	3	3	5	2	1	5							1			48	12	13
Oklahoma		3		4		1		2		2			1					2		3			18	8	7
Texas	6	16	1	26	2	10		9	2	1	2		3			1			1	5		1	86	15	23
Wyoming	1	5		10		3		10	2	1			2	1				3					38	10	10
NORTH CENTRAL, HARD RED SPRING																											
Iowa		5	1	23		6		2	2	1			5					4		5		1	55	11	14
Minnesota		6	1	16		6		18	2		4							1		6			60	9	21
North Dakota	1	7		8			1	3	1				1					2	2	2		1	29	11	9
South Dakota		1		5			1	1															8	4	2
Wisconsin			7	1				3	1														12	4	6
NORTHWESTERN, SOFT WINTER																											
Idaho		1	3	1										7	2								14	5	4
Totals	49	110	60	251	3	75	16	110	44	13	11	1	35	13	3	3	6	51	10	62	2	6	933		285
Percent of total isolates	5.3	11.7	6.4	26.9	0.3	8.0	1.7	11.8	4.7	1.4	1.2	0.1	3.8	1.4	0.3	0.3	0.6	5.5	1.1	6.6	0.2	0.6			
Percent of total isolates for group	17.0		6.4	27.2		26.2				6.5				1.7		0.3		13.8			0.2	0.6			

SMALL GRAIN DISEASES IN NEW JERSEY, 1955-56

R. A. Cappellini and S. Lund

The 1955-56 season was generally good for small grains in New Jersey. Grain yields were relatively high and disease losses low. The diseases which occurred, however, were general throughout the State. The following diseases were noted:

Crop and Disease	Pathogen
WHEAT:	
Loose Smut	Ustilago tritici
Leaf Rust	Puccinia rubigo-vera tritici
Powdery Mildew	Erysiphe graminis tritici
Scab	Gibberella zeae
Foot Rot	Rhizoctonia solani
Leaf Spot	Helminthosporium tritici-repentis (?)
BARLEY:	
Loose Smut	Ustilago nuda
Net Blotch	Helminthosporium teres
Scald	Rhynchosporium secalis
Scab	Gibberella zeae
Powdery Mildew	Erysiphe graminis hordei
Stripe Mosaic	Barley Stripe Mosaic Virus
OATS:	
Crown Rust	Puccinia coronata
Smuts	Ustilago avenae and U. kolleri
Red Leaf	Unidentified
RYE:	No Disease Noted

Loose smut in wheat showed an increase over preceding years. This was due probably to cool weather during the flowering period in 1955. The incidence of loose smut was above the established tolerance for certification on Seneca, one of our most important soft winter wheats. This caused a serious shortage of certified seed of this variety. Considerable leaf rust was found on seedlings in the fall of 1955 in early planted fields. Traces of this rust were also noted the following summer on late-maturing varieties. A Helminthosporium leaf spot caused moderate damage in several fields in Hunterdon County. No previous record of this disease in New Jersey had been noted. The organism was tentatively identified as Helminthosporium tritici-repentis Died. Both powdery mildew and Rhizoctonia foot rot were common throughout the State on barley but they were of minor importance. Scab was found in most fields of wheat and barley but was of little importance except where these grains followed corn in the rotation.

The hot water treatment program in the production of certified seed has effectively controlled loose smut in barley in New Jersey although trace amounts were present in most fields. Net blotch occurred in nearly all barley fields examined and was the most prevalent of leaf disorders. Scald was generally evident but caused little damage in most fields. Stripe mosaic was found in only one lot of barley and appears to be of little consequence to barley production at present. Trace amounts of powdery mildew were insignificant because of the resistance of our recommended varieties.

Oat diseases were of little importance. Leaf reddening was prevalent on spring oats. Certain symptoms suggested the possibility of red leaf virus infection but no transmission studies were made.

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TERMINAL BLEACH OF CEREALS

Michael Treshow

Terminal bleach, the sudden appearance of whitened leaf tips of cereals, has been observed by gowers possibly over the centuries. Especially is this so wherever wheat, barley, or oats have been grown under irrigation and whenever such crops in arid areas are exposed to drying winds. Economic losses have been encountered in some fields during years where the disease was of greatest severity. Dr. B. L. Richards, who pioneered in Plant Pathology in the State of Utah, reports that he observed the disease since the early 1920's[1]. The accompanying photograph (Figure 1), taken by him in 1929, provides a clear picture of what is generally recognized as terminal bleach.

As shown in Figure 2, terminal bleach is characterized by a necrosis or white "bleaching" of the tips of the flag leaf and other upper, young leaves. The earliest indication of the disease is the rapid breakdown of the chlorophyll of affected leaf areas. This involves the leaf tips, particularly of the most vigorous plants. These leaf tips first turn a dark, gray-green color, and rather rapidly lose all their green coloration. Within about 24 hours, the leaf tips become almost white. The bleached, white appearance distinguishes terminal bleach from the dull, brown appearance more commonly found on cereal crops and incited by various other factors. The necrotic portion of the leaf is sharply delimited from the remaining green tissues. Occasionally, white flecks are apparent in the green tissue slightly below the margin of the main necrotic area. The necrosis may involve up to half or two-thirds of the leaf. Most frequently, 1 to 3 inches of the leaf tips become bleached.

The disease as observed from a distance appears as pale yellow or white areas in the field where leaf tips of numerous plants in certain areas or rows have been "bleached".

A critical study was made from 1953 through 1956 of the severity and distribution of the disease throughout Utah.

Distribution: In a survey of Cache, Davis, Box Elder, Salt Lake, Utah, Wasatch, and Weber Counties made in 1953, terminal bleach was found in a total of 23 fields. In 1954 and 1955, the disease was not observed in any of the fields inspected although it may have been present in those not studied. The 1956 survey revealed the presence of terminal bleach in approximately one-fourth of the fields observed although to a lesser degree of severity than in 1953. Such wide distribution has been characteristic of the disease over the years.

The disease was present on soils of both high and low salt concentrations. Entire fields or, more commonly, local areas in a field may be affected depending on the predisposition of the plants to terminal bleach.

Etiology: Wind, especially when accompanied by high temperatures, causes an excess transpiration in some plants to a degree whereby the root system is unable to supply sufficient water to maintain a proper water balance in the leaves. The "bleaching" of portions of the more exposed and predisposed leaves may thereby result from the dessication of those leaves which suffer the greatest water stress.

The sudden and general appearance of terminal bleach throughout several counties indicated that this disease might well have been induced by an abrupt environmental change. In 1953, a long, cool spring ended abruptly on June 9 when the temperature rose to over 80° F. This was accompanied by unusually high winds during the 48-hour period ending June 9. During the same period of plant growth in 1954 and 1955, no such weather patterns occurred. The hot, dry winds of 1953 were largely absent and high temperatures did not prevail until late in the plant's development. Terminal bleach was also absent in the plantings inspected during 1954 and 1955. The presence of terminal bleach in 1956 also showed a general correlation with the temperature pattern, which was similar to that recorded in 1953 in that a cool moist spring, conducive to lush growth, was followed suddenly by high temperatures and winds.

The severe, arid weather frequently encountered in Utah makes the control of terminal bleach highly improbable. The disease may be minimized through avoiding excess irrigation during the early, succulent period of growth.

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[1] Richards, B. L. 1929. A plant disease survey of Utah. Utah Acad. Sci. 6.

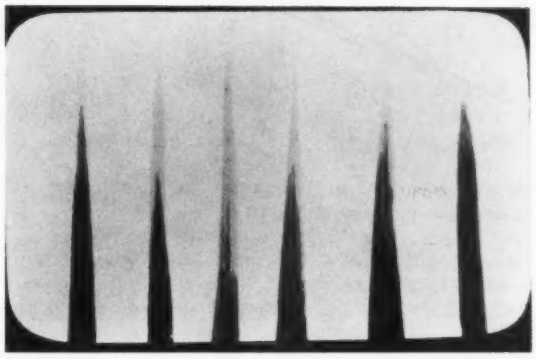

FIGURE 1. Photograph, taken by B. L. Richards in 1929, characterizing terminal bleach.

FIGURE 2.
Typical terminal bleach of wheat photographed in 1953.

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PRODUCTION OF LEAF CHLOROSIS IN RED CLOVER BY THE ADDITION OF CHEMICALS TO THE SOIL[1]

S. B. Hrushovetz, J. B. Lebeau, and H. B. Stelfox[2]

SUMMARY

A disease causing necrosis and wilting of red clover at the Experimental Station, Lacombe, Alberta, was investigated. Gram-negative, short-rod bacteria, isolated from the necrotic lesions, were found to be nonpathogenic. Experimental plants were treated with solutions of KOH, NaOH, Na_2CO_3, $NaHCO_3$, Na_2SO_4, NaCl, $CaCl_2$, and $BaCl_2$. Several of these chemicals induced chlorosis but severe symptoms developed only under conditions of high soil alkalinity.

One of the authors (5) recently reported that water containing 131 ppm of sodium in the form of sodium bicarbonate supplied to the plants in the greenhouse was responsible for a serious leaf disease of red clover at the Experimental Station, Lacombe, Alberta. Early symptoms consisted of chlorotic patches on the leaves, both interveinal and marginal. The interveinal lesions resembled those of bacterial leaf spot (2), while the marginal symptoms were not unlike those reported for Curvularia trifolii (Kauffm.) Boed. (3). As the disease developed, chlorosis became more pronounced and finally the leaves became dry, curled and necrotic (Fig. 1). The formation of nodules and development of a lateral root system appeared to be greatly retarded in these diseased plants.

Isolations were made from the necrotic lesions on the diseased leaves and a Gram-negative short-rod bacterium was the only organism recovered. All attempts to reproduce the symptoms failed when this bacterium was used as a source of inoculum. The pH of the soil surrounding the roots of the diseased plants was 8.2, whereas the pH of the soil used for potting these plants was 6.6.

It was thought at first that the disease resulted from sodium toxicity; however, high concentrations of bicarbonate ions, high pH and high lime content are soil factors commonly associated with plant chlorosis (1, 4). It was felt, therefore, that a more thorough investigation might determine whether pH, sodium, or the bicarbonate ion was responsible for the chlorosis.

Four-week-old Siberian red clover plants, growing in 6-inch pots containing Edmonton black loam, were used for the test. Determinations were made of the pH of the soil of each pot in which the plants were growing before the addition of the chemicals. The initial pH was 6.53 ± 0.11. The plants were treated with solutions containing 50 ppm of the cations of the following chemicals: potassium hydroxide, sodium hydroxide, sodium carbonate, sodium bicarbonate, sodium sulfate, sodium chloride, calcium chloride, and barium chloride. Each treatment was replicated three times and 50-ml portions of the respective solutions were added to the plants in each pot every 48 hours for 4 weeks. The treatment was then increased to daily additions of 125 ml of the stock solutions for an additional 11 weeks. The pH of the soil was determined weekly until chlorosis appeared at approximately 5 weeks from the beginning of the experiment. Symptoms were fully developed at the end of 105 days and a final pH determination of the soil was made (Table 1).

It was apparent from the experiment that several chemicals may induce chlorosis in red clover plants (Table 1). The symptoms observed were similar to those that developed on the plants at Lacombe (Fig. 1), except that necrosis and the downward curling of the leaves developed more rapidly under the experimental treatments in the greenhouse at Edmonton.

The first four compounds, potassium hydroxide, sodium hydroxide, sodium carbonate, and sodium bicarbonate, were about equally effective in producing typical symptoms of the disease. The disease was not produced when an equivalent amount of sodium was applied in the form of

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[1] Joint contribution from the Botany and Plant Pathology Division, Science Service (Contribution No. 1579), and the Forage Crops Division, Experimental Farms Service, Canada Department of Agriculture, Ottawa, Ontario.

[2] Formerly Associate Plant Pathologist, Associate Plant Pathologist, Plant Pathology Laboratory, Edmonton, Alberta; and Agronomist, Experimental Station, Lacombe, Alberta, respectively.

FIGURE 1. Curled and necrotic leaves of red clover plants watered from the town mains of Lacombe, Alberta.

FIGURE 2. Red clover plants showing chlorosis after being watered with solutions of $NaHCO_3$. Left to right: 0; 500; 1,000 ppm Na.

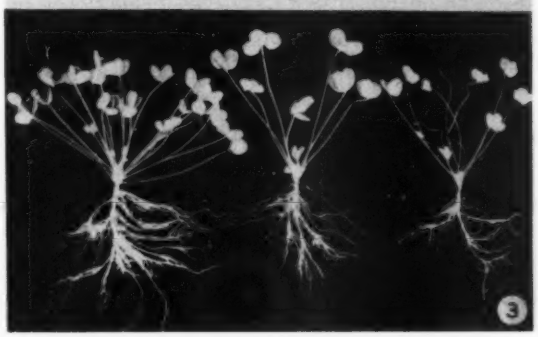

FIGURE 3. Red clover plants removed from the pots illustrated in Figure 2. Note resulting degeneration of the roots in plants treated with high concentrations of $NaHCO_3$.

Table 1. Chlorosis induced in red clover plants by the application of various chemicals to the soil.

Compound added	Final pH of the soil	Extent of chlorosis
KOH	8.48	Severe
NaOH	9.58	Severe
Na_2CO_3	9.18	Severe
$NaHCO_3$	9.12	Severe
Na_2SO_4	6.2	Trace
NaCl	6.36	Moderate
$CaCl_2$	6.3	Trace
$BaCl_2$	6.35	Moderate
None	6.32	None

sodium sulfate. Chlorosis occurred when sodium chloride or barium chloride was applied to the plants, but did not develop when calcium chloride was used. The pH of the soil in these three latter treatments was little different from that of the control, hence it is possible that the chlorine ion caused chlorosis in the presence of added sodium and barium ions in the soil but not when additional calcium ions were present.

Although several compounds caused chlorosis in red clover, severe symptoms did not develop in these experiments until the pH of the soil reached 8.4. These facts suggest that the alkalinity of the soil may be more important in producing the above described disease of red clover than the quantity of sodium ions present.

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FORAGE CROP DISEASES IN NEW JERSEY -- 1956

R. A. Cappellini

Diseases of forage crops were observed, prior to the first cutting in 1956, in 120 fields in 11 New Jersey counties. Approximately 65 percent of the fields observed consisted of alfalfa or alfalfa-grass mixtures; the remainder consisted of clover-grass mixtures and a few pure stands of birdsfoot trefoil, orchard grass, or timothy.

The following diseases were observed:

Crop and Disease	Pathogen
ALFALFA:	
Alfalfa mosaic	Alfalfa mosaic virus
Bacterial wilt	Corynebacterium insidiosum
Common leaf spot	Pseudopeziza medicaginis
Sclerotinia crown and stem rot	Sclerotinia trifoliorum
Southern anthracnose	Colletotrichum trifolii
Spring black stem	Ascochyta imperfecta
Stemphylium leaf spot	Pleospora herbarum
Yellow leaf blotch	Pyrenopeziza medicaginis
RED CLOVER:	
Mosaic	Virus not identified
Red clover vein mosaic	Red clover vein mosaic virus
Pepper spot	Pseudoplea trifolii
Powdery mildew	Erysiphe polygoni
Root rot	Fusarium spp.
Sclerotinia crown and stem rot	Sclerotinia trifoliorum
Target spot	Stemphylium sarcinaeforme
LADINO CLOVER:	
Mosaic	White clover mosaic virus
Yellow patch	Alfalfa mosaic virus
Cercospora leaf and stem spot	Cercospora zebrina
Pepper spot	Pseudoplea trifolii
BIRDSFOOT TREFOIL:	
Leaf spot and stem canker	Stemphylium loti
BROME GRASS:	
Brown spot	Pyrenophora bromi
Leaf rust	Puccinia rubigo-vera
ORCHARD GRASS:	
Purple leaf spot	Stagonospora maculata
Scald	Rhynchosporium orthosporum
Stripe smut	Ustilago striiformis
TIMOTHY:	
Eye spot	Heterosporium phlei
Stripe smut	Ustilago striiformis

Only a few of the observed diseases were widespread. Spring black stem was common throughout the State on alfalfa. The Sclerotinia crown and stem rot disease on alfalfa was significant only in the central and southern counties, and especially on newly seeded fields. Losses from 30 to 50 percent in stand were observed in several new alfalfa fields in three southern counties; one field was a complete loss. Root rot was the most severe disease on red clover, followed to a lesser degree by Sclerotinia crown and stem rot and virus diseases (especially red clover vein mosaic). Pepper spot, yellow patch, and mosaic were the most common diseases on ladino clover. The prevalent grass diseases were brown spot on brome grass and purple leaf spot on orchard grass.

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REDUCTION IN YIELD OF COTTON CAUSED BY DISEASES IN 1956

Compiled by the Cotton Disease Council, Committee on Disease Losses, Philip J. Leyendecker, Chairman; A. L. Smith, W. E. Cooper, Leonard Lett.

The 1956 Cotton Disease Loss Estimate (Table 1) is the fifth summary submitted by the committee on cotton disease losses.

The summary was compiled, as in previous years, from 46 state estimates. The accuracy of the estimates is highly reliable because most of the same cooperators have contributed for the last 5 years and as a consequence their methods and techniques are becoming uniform. The committee feels that considerable credence can be placed in the report.

The 5-year summary (Table 2) shows the annual trends of losses caused by the major cotton diseases in the United States.

The committee wishes to acknowledge the help of all who contributed to the report and further solicit their cooperation in making the cotton disease loss summary a continuing success.

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Table 1. Estimated reduction in 1956 cotton yield caused by diseases.

DISEASES	CALIF.	ARIZ.	N. MEX.	TEX.	OKLA.	MO.	ARK.	LA.
1. FUSARIUM WILT *F. vasinfectum*	-	-	-	.1	.1	4.0	3.5	2.5
2. VERTICILLIUM WILT *V. albo-atrum*	2.0	3.5	7.0	1.7	tr	.5	1.0	tr
3. BACTERIAL WILT *Xanthomonas malvacearum*	tr	.1	.1	3.9	7.0	.5	.25	.5
4. ROOT ROT *Phymatotrichum omnivorum*	tr	2.8	.1	2.3	.1	-	tr	tr
5. ANTHRACNOSE BOLL ROT *Glomerella gossypii*	-	-	-	.1	tr	.1	tr	.5
6. SEEDLING DISEASES *Rhizoctonia*, etc.	3.5	2.4	2.0	2.7	3.0	5.0	2.0	3.0
7. ASCOCHYTA BLIGHT *A. gossypii*	-	-	-	tr	-	.5	tr	tr
8. BOLL ROTS *Rhizopus*, etc.	1.5	.6	tr	.2	1.0	.5	4.3	3.0
9. ROOT KNOT *Meloidogyne* sp.	1.8	2.3	2.0	.5	.5	1.0	.75	tr
10. OTHERS	tr[a]	.13[b, c]	tr[b]	tr[b]	-	-	-	-
TOTAL PERCENT LOSS	8.8	13.0	11.2	11.5	11.7	12.1	11.8	9.5
TOTAL BALES LOST	126,403	123,276	35,946	467,797	34,451	59,192	193,322	60,884
YIELD BALES 1956[d]	1,310,000	825,000	285,000	3,600,000	260,000	430,000	1,445,000	580,000

DISEASES	MISS.	ALA.	GA.	S.C.	N.C.	TENN.	BALES LOST	PERCENT LOSS
1. FUSARIUM WILT *F. vasinfectum*	2.25	1.0	2.0	1.0	1.0	.5	171,638	1.17
2. VERTICILLIUM WILT *V. albo-atrum*	.5	tr	-	-	.4	2.0	194,412	1.33
3. BACTERIAL WILT *Xanthomonas malvacearum*	1.0	.3	.25	2.25	.75	.2	229,621	1.56
4. ROOT ROT *Phymatotrichum omnivorum*	-	-	-	-	-	-	120,726	.82
5. ANTHRACNOSE BOLL ROT *Glomerella gossypii*	.75	1.5	.25	1.0	.5	.2	44,206	.30
6. SEEDLING DISEASES *Rhizoctonia*, etc.	1.5	.5	6.25	4.25	2.5	.5	385,033	2.63
7. ASCOCHYTA BLIGHT *A. gossypii*	-	tr	.2	.5	.1	.2	8,298	.06
8. BOLL ROTS *Rhizopus*, etc.	2.25	2.5	.75	1.75	1.0	1.0	216,175	1.47
9. ROOT KNOT *Meloidogyne* sp.	.5	3.5	2.0	4.0	2.5	.5	180,713	1.23
10. OTHERS	-	-	-	-	-	-	12,327	.08
TOTAL PERCENT LOSS	8.75	9.3	11.7	14.75	8.75	5.1		10.65
TOTAL BALES LOST	155,342	76,902	78,177	87,375	34,521	29,557	1,569,149	
YIELD BALES 1956[d]	1,620,000	750,000	590,000	505,000	360,000	550,000	13,153,000	

[a] Crumple leaf virus
[b] Rust (*Puccinia stakmanii* Presley)
[c] Crazy Top
[d] Nov. 1, 1956 BAE Estimate

Table 2. Summary of reduction in yield caused by the major cotton diseases in the United States from 1952 to 1956.

DISEASES	1952* BALES	1952* %	1953 BALES	1953 %	1954 BALES	1954 %	1955 BALES	1955 %	1956 BALES	1956 %	TOTAL LOSS BALES	AVERAGE LOSS BALES	AVERAGE LOSS %
SEEDLING DISEASES (Rhizoctonia, etc.)	500,457	3.32	431,473	2.28	460,856	2.91	363,533	2.67	385,033	2.63	2,141,352	428,270	2.76
BACTERIAL BLIGHT (Xanthomonas malvacearum)	275,760	1.35	240,796	1.27	112,341	.71	222,611	1.08	229,621	1.56	1,081,129	216,226	1.19
ROOT KNOT (Meloidogyne sp.)	188,225	1.32	322,590	1.70	175,479	1.11	164,795	1.35	180,713	1.23	1,031,802	206,360	1.34
VERTICILLIUM WILT (V. albo-atrum)	61,277	.45	399,009	2.10	160,196	1.01	189,168	1.38	194,412	1.33	1,004,062	200,812	1.25
FUSARIUM WILT (F. vasinfectum)	163,518	1.12	256,253	1.36	191,510	1.21	173,883	1.29	171,638	1.17	956,802	191,360	1.23
BOLL ROTS (Rhizopus, etc.)	199,620	1.52	103,842	.55	114,360	.72	322,082	2.75	216,175	1.47	956,079	191,216	1.40
ROOT ROT (Phymatotrichum omnivorum)	137,865	.65	149,627	.79	114,410	.72	164,236	.42	120,726	.82	686,864	137,373	.69
OTHERS	220,681	1.12	67,218	.36	55,246	.36	106,062	.51	64,831	.44	514,038	102,808	.56
TOTAL	1,727,403	10.85	1,970,808	10.41	1,384,398	8.75	1,706,370	11.45	1,563,149	10.65	8,342,128	1,674,425	10.42

*California not included.

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COTTON DISEASE COUNCIL, COMMITTEE ON DISEASE LOSSES

SOME CORRECTIONS

June REPORTER, Volume 40, No. 6, article by H. H. McKinney, page 520, paragraph 4: The spring barley variety should read Olli.

September REPORTER, Volume 40, No. 9, article by G. Minz, pages 798-801: On page 800, in the list of hosts of Meloidogyne spp., instead of Prunus carassia (sour) should read Prunus cerasia (sour). This is a local species.

BOOK REVIEWS

"DISEASES OF FIELD CROPS", by James G. Dickson. New second edition. xi + 517 pages. 1956. McGraw-Hill Book Company, Inc., New York, Toronto, London. Price $8.50.

This book reviews the principal diseases of field crops, which include the cereals, the legumes, the grasses, and the fiber crops, primarily as they occur in the United States. It is not meant to be an exhaustive list of every disease afflicting each crop, but rather is a comparatively brief explanation of those diseases that have some economic significance.

In terms of appeal, Diseases of Field Crops possibly will have less utility for the farmer who is looking for a sure way to end his disease problems than it will have for the student, owing to the fact that the control methods given are very general in nature. For example, the author mentions crop rotation, or fungicides, or the prevention of spore dissemination, or the use of resistant varieties as methods of control, but he is not always specific as to just what crops to rotate, just what fungicides and in what strength one should use, how one prevents spore dissemination, or which varieties are resistant to the particular disease. Conversely, however, the book should serve as an excellent text for students who are being first introduced to the diseases of field crops in a survey course, where a general knowledge of the subject is desired, rather than where there is a need to exchange theory for actuality in practical application. Also, this text should make a fine reference book, since in many cases where space does not allow for a fuller discussion of the subject at hand, the writer has noted where the omitted material may be found.

Chapter 1, the Introduction, scans the background of field crops diseases, mentions progress currently being made in the investigation of various diseases, and cites the chief contributors to the fields of non-parasitic and parasitic diseases. Chapter 2 deals with the physiological anatomy of the plant groups that are included in the text material, i.e. the grasses, the legumes, and other dicots. This chapter also gives a résumé of plant defense mechanisms.

For the remainder of the book, one chapter is devoted to each major field crop, with the diseases being treated separately under each crop. In general, more space is allotted to the more important diseases on the more important crops than to the less important diseases on the less important crops in the United States. Each chapter begins with the naming of the host crop and any or all of the species or varieties of the plant that are grown for food, feed, or fiber purposes. The chromosome numbers of these types are given and any other additional pertinent information about the crop. For rye, oats, corn, barley, wheat, and cotton the annual crop losses for the ten-year period 1930-1939 are reported as issued by the Plant Disease Survey. The diseases are then listed individually according to cause, in the following order: non-parasitic, virus, bacterial, and fungal. For each disease the causal factor is named, the symptoms of the disease and its distribution are described, the etiology of the disease is explained, and, finally, the control methods recommended are given.

For easy cross-referencing purposes two appendices are added in the back: Appendix A -- a listing of diseases of field crops arranged by causal (spelled "casual" in the title of the appendix) factor, and Appendix B -- the bacteria and fungi parasitic on field crops, showing the more common host and the page or pages in the text where they may be located.

It is to the credit of this book that it is so lucidly written and that the subject matter is presented in so logical an order. It is further to be commended that, while no attempt has been made to elaborate on a dearth of information, still when an abundance of material has been available, the reader is given any necessary data without being burdened by many unimportant and often tiresome details. -- (H. M.)

"DISEASES OF FRUIT CROPS", by Harry Warren Anderson. vii + 501 pages. 1956. McGraw-Hill Book Company, Inc., New York, Toronto, London. Price $8.50.

Although not so indicated in the title this book is limited in scope to parasitic and non-parasitic diseases of deciduous fruits, in the United States and Canada for the most part. Except for some of major importance diseases occurring in other countries but not present in the United States and Canada are mentioned only briefly or are omitted.

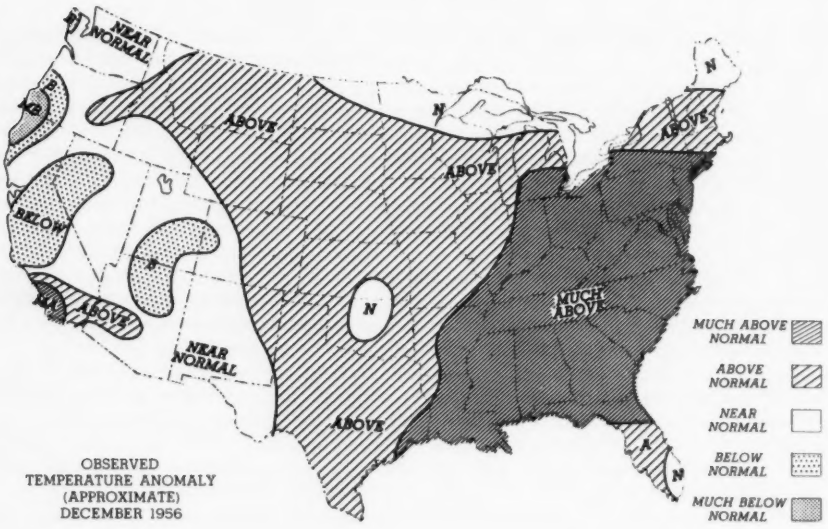
Dr. Anderson notes that the only other book on fruit diseases in this region was published some 36 years ago. This is a very long time between summaries, all the more so since this particular period was one of very rapid change in accumulated knowledge and fundamental understanding. Some of the major accomplishments of research during this time include by far the greater part of what is known about virus diseases, especially the complicated situation in stone fruits, the development and use of indexing to prevent spread of viruses with planting stock, recognition of the importance and variety of parasitic nematodes, and appreciation of the role of soil microflora in some obscure root disease complexes. Above all, a completely new era in chemical control has developed in spectacular fashion. All of these advances are brought out in the book, in one place or another.

Background information in Chapter 1, the Introduction, includes a statement on importance of plant diseases and an account of changes in fruit production and disease problems during the 50-year period covered by the book. Heald's definition is quoted to show the fundamental "broad conception" of disease in plants. The agents that cause disease are classified and described, symptoms are defined, and the various means whereby diseases are combatted are explained, with a final brief exposition of new principles of disease control.

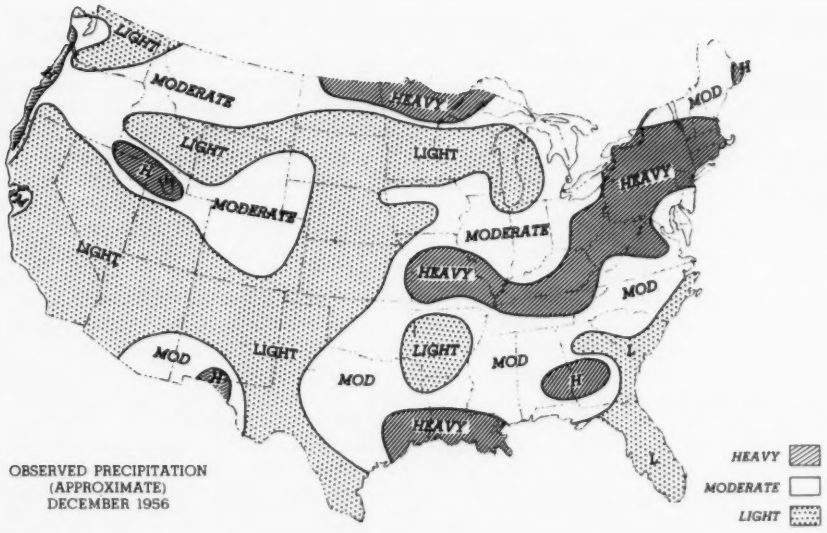
The rest of the book takes up individual diseases under their hosts. Pome fruits are allotted four chapters, drupe or stone fruits two, and brambles, grapes, strawberries, gooseberries and currants, cranberry, and blueberry, are given one chapter each.

The general outline for parasitic diseases includes history, distribution, importance, and symptoms of the disease; classification, host range, and morphology of the causal organism; the disease cycle; relation to environment; and control. Non-parasitic diseases are similarly discussed except of course for the part relating to the causal agent. Mostly only factual material is included but on some controversial or undecided points the various hypotheses are presented, "in order", as the author says, "to give the student a viewpoint."

The symptom descriptions are especially noteworthy, being very complete and clear with particular attention to features that help to distinguish between closely similar diseases. --(J. I. W.)



OBSERVED
TEMPERATURE ANOMALY
(APPROXIMATE)
DECEMBER 1956



OBSERVED PRECIPITATION
(APPROXIMATE)
DECEMBER 1956

The terms used in the accompanying maps, which define the ranges of temperature and precipitation, are numerical class limits. These are based on a statistical analysis of past records through which is determined the normal frequency of occurrence of temperatures and precipitation at various times of the year for different locations. For temperature the classes above, below, and near normal are so defined that they each normally occur one-fourth of the time; much above and much below normal, one-eighth of the time Precipitation is depicted in terms of light, moderate, and heavy, each class normally occurring one-third of the time and thereby having equal probability of occurrence. These maps graphically represent only the general trends and give the country's weather picture at a glance. For quantitative studies, where monthly mean temperatures and actual precipitation records are needed for a given time and place, other publications of the Weather Bureau should be consulted. P. R. M.